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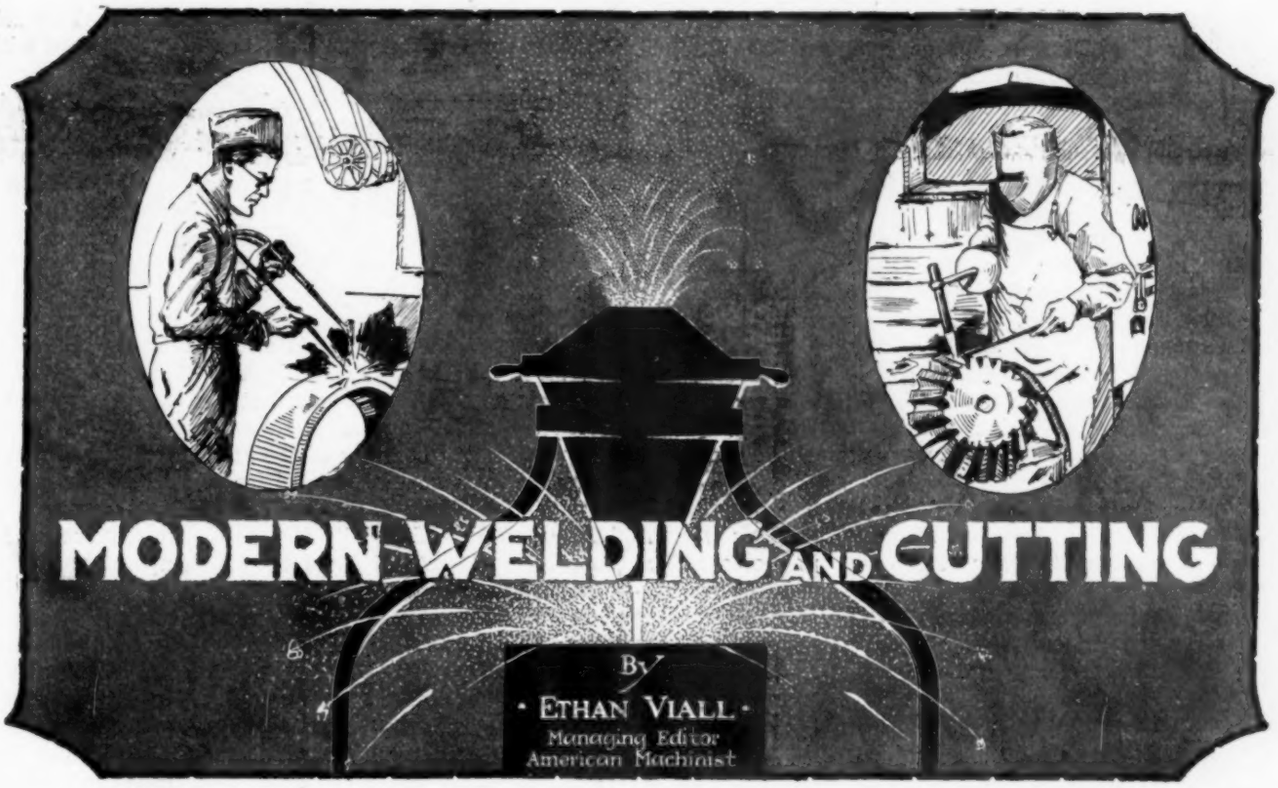


VIII. History and Uses of the Gas Torch

This the first of the articles dealing with the use of the gas torch for welding and cutting. While the fields of the gas torch and thermit welding overlap in some places, in general, their limitations are pretty well defined. These limitations will be brought out clearly as the series unfolds. The present series dealing with gas torch work, is planned to cover the subject more comprehensively from the standpoint of the actual user, than anything that has ever been published.

ACCORDING to common usage, the term "autogenous welding" is eroneously applied only to hot gas flame fusion welds. The gas combinations used for the production of the hot flame for welding or cutting are oxy-acetylene, oxy-hydrogen, oxy-thermalene or any combination that will produce sufficient heat, and is applied by means of a torch or blow-pipe. The welds so produced are strictly fusion welds, as no pressure or hammering is employed to effect the union. The word "autogenous" means "self-produced" or "self-generated," that is, joined with the same metal, and as such applies equally to hot gas flame, electric arc or thermit welds, although as just stated, the present custom is to apply the term generally to hot gas flame welds. However, owing to the wide field that the term "autogenous" really covers, and to the looseness with which it is often applied, we prefer to use the term "gas torch" in connection with welding and cutting by means of the hot gas flame.

While the use of a blow-pipe or torch in some form was known to the ancients, the high temperature gas flame is a development of the last quarter of a century. The more commonly known gas combination is oxy-acetylene. Acetlyene (C_2H_2) was discovered by Edmund Davy in 1836, but it remained only a laboratory gas until T. L. Willson of North Carolina, and H. Moisson, the Frenchman, developed commercial methods of producing calcium carbide (CaC_2) in large quantities in 1891-92. In 1895 Le Chatelier read a paper before the Paris Academy of Sciences in which he stated that: "acetylene burned with an equal volume of oxygen gives a temperature which is 1000 deg. C. (1800 deg. F.) higher than the oxy-hydrogen flame. The products of the combustion are carbon monoxide and hydrogen, which are reducing agents." Further along he said: "this double property makes the use of acetylene in blow-pipes of very great value for the production of high temperatures in the laboratory." This statement of Le Chatelier is especially noteworthy, since he set the ratio of the gases at equal volumes, and not at the theoretical proportion of 2½ volumes of oxygen to 1 of acetylene.

The application of the oxy-acetylene gas torch to metallic welding dates experimentally from 1901, and industrially from 1903. Edmond Fouche, of Paris, who did considerable experimenting in conjunction with Picard, is generally credited with having devised the first really practical and safe torch. In February 1904 Fouche sent two of his torches to Eugene Bournonville, of New York, with which the latter repaired a machine that was still in use years later. The Fouche and Picard torch first developed, used both oxygen and acetylene under high pressure. There proved to be serious objections to this, and Fouche next produced the low pressure

or injector type of torch which employed only the oxygen under high pressure. Following these was the Gauthier-Ely positive pressure or medium-pressure type which used both gases under moderate and independent pressures. This type was later brought to the United States by Augustine Davis and Eugene Bournonville in 1906. During this year Bournonville designed the first acetylene pressure generator produced in connection with the oxy-acetylene process.

In 1905 and 1906 considerable welding work was done but the process was handicapped by the inadequacy and poor quality of the oxygen then obtainable, and also by the imperfect knowledge and technique necessary to good work. In 1902, Carl Linde patented in England a process for liquefying air and producing oxygen and nitrogen. In 1906 a plant for the production of oxygen by the Linde process was established in Buffalo, N. Y. From that time on, oxygen plants of various kinds have constantly increased in number and the commercial production of oxygen of good quality has been a great factor in the development of gas torch welding.

At first, operations were limited to the simplest repair work on iron or steel. As the apparatus was improved and the efficiency of the welders increased, the field widened. New uses have been found for the process and the range of metals coming within its scope has steadily expanded. It has its limitations, however, which will be pointed out elsewhere.

Used for Both Welding and Cutting

In addition to welding, the oxy-acetylene flame, as well as a number of others, is applicable to cutting. In fact so closely allied are welding and cutting in this field, that an operator is usually called upon to do both many times in a day's work. Cutting by means of an oxygen jet was first made commercially possible by Jottrand who took out his basic patent in 1905.

Aside from the manual operation of welding or cutting torches, a large number of machines have been designed. These range from simple wheel or radius attachments for the torch itself, to huge automatic pipe making machines or others of a complicated nature.

The oxy-acetylene flame consists of two parts, a small inner luminous "cone" which is bluish white in color, and a larger enveloping non-luminous flame. The temperature at the apex of the cone is estimated to be about 6300 deg. F. This heat is not surpassed by any burning gas with the possible exception of thermalene, for which 6500 deg. F. is claimed.

For welding purposes the high efficiency of acetylene is due to its high carbon content and to the fact that it is endothermic, that is to say, heat-absorbing in its formation. Energy stored up in formation is given off again in the form of heat by the acetylene upon dissociation. It is calculated that of 1475 heat units in a cubic foot, 227 are due to the mere breaking up of the gas. While theoretically two and one half volumes of oxygen are needed to completely burn one volume of acetylene, the ratio in which the gases are employed in practice is about one volume of oxygen to one volume of acetylene. The flame yielded by such a mixture is the correct one, or the so-called "neutral" flame. By increasing or decreasing the proportion of oxygen, flames known as either oxidizing or reducing may be obtained, the appearance of the cone changing as the proportions are modified.

While the use of oxy-acetylene for welding is more commonly known than any other combination, there are several gases, which when mixed with oxygen, will produce more or less satisfactory welds. Some of them are to be preferred to acetylene for certain cutting purposes. The better known gases are described as follows, it being understood that they are to be used with oxygen.

Hydrogen gas is a chemical element which exists in nature in great quantities in various chemical combinations. The most common is its union with oxygen to form water (H_2O). As a consequence, water is used as a basis for making both oxygen and hydrogen. Oxy-hydrogen welding was the first gas torch welding system employed, and it was used quite extensively until the introduction of the more advantageous system of welding with oxy-acetylene. While hydrogen may be manufactured on the premises, it is also handled commercially in steel cylinders. In using this flame for welding there is an existing danger that the oxygen may unite with the metal causing it to be overheated or burnt. To prevent the burning of the metal, it becomes necessary to use a supercharge of hydrogen so that oxygen liberated within the flame will combine with the free hydrogen instead of with the metal. This, however, increases the size and decreases the temperature of the flame. The temperature of the oxy-hydrogen flame according to Kautny, can never go higher than the dissociation temperature of water, which is estimated at 2000 deg. C (3632 F.). For welding thin metal sheets hydrogen is practical on account of its comparatively low heat. The quality of the weld, however, decreases as the thickness of the metal increases. While theoretically only two volumes of hydrogen are required to one of oxygen, in actual practice when employing an oxy-hydrogen torch, it is necessary to use four or five volumes of hydrogen to one of oxygen in order to insure a non-oxidizing flame. This in itself is a wasteful process, since the maximum heat obtained is limited to the amount produced by combining two volumes of hydrogen to one of oxygen. For heavy cutting it is preferred to acetylene on account of its longer flame. It is also used extensively for lead burning, preheating, soldering, brazing, annealing, special forging or rivet heating and a number of other things.

Thermalene is one of the latest gases to be produced. It is the discovery of Linus Wolf, Zurich, Switzerland, and it is handled in this country by the Thermalene Co., Chicago Heights, Ill. It is a combination produced by the decomposition of calcium carbide and hydrocarbon oils, the heat generated by the carbide being used to vaporize the oil. It is used for either welding or cutting.

Blaugas is a liquid under pressure. It is the discovery of Herman Blau and it is made from gas oil, a product of the oil refineries. It probably has the lowest explosive range of any gas used for illuminating purposes, the range being about 4% while that of coal gas is about 13%. Like coal gas however, it is little used for welding, though sometimes used for cutting. Blaugas is marketed in steel cylinders having the equivalent of 1300 cu.ft. of city gas, by the American Blaugas Corp., New York. Its largest field is for cooking and lighting purposes where coal gas is not readily obtainable. Owing to its portability it may be used to advantage for preheating work.

Drigas is a light oil gas, which is a vapor under pressure. It is sold in steel cyclinders of about 150 cu.ft. by the same concern handling blaugas. It is

especially good in combination with oxygen for cutting metal from 1 to 12 in. thick, and is also considerably used for preheating. Its explosive range is about ⅓ that of coal gas, and it is non-poisonous and non-asphyxiating.

ILLUMINATING GAS (coal gas or water gas) can only be used for welding very thin pieces owing to the low temperature of the flame. It may however, be used for preheating or cutting.

BENZINE OR BENZOL VAPORS have the same properties, approximately, as blaugas. The temperature is a little higher than that of illuminating gas, but much lower than acetylene. It is only used for welding under special circumstances.

While a number of gases, which are used with oxygen, have been mentioned, only the production and use of hydrogen, acetylene and thermalene will be described, along with that of oxygen.

EXPLOSIVE LIMITS OF WELDING GASES

In order to be explosive, a combustible gas or vapor must be mixed with a certain amount of oxygen or air, the proportions of the mixture ranging between certain limits depending on the character of the fuel. Any figures showing these explosive limits of the gases can only be approximate at best, since so many things enter into the calculations, such as the purity of the gas, means of ignition, temperature, pressure, and so on. In general, the mixture that has just enough oxygen for complete combustion of the fuel gives the highest pressures and temperatures, and very nearly the highest speed of ignition. If the proportion of oxygen (air) is increased beyond, or decreased from, the theoretical proportion, the maximum pressures and temperatures are lowered and the speed of ignition decreases until at certain upper and lower limits the mixture ceases to be explosive, and only slow combustion can occur.

The figures here given are believed to be a fair average of those given by the various authorities. The explosion is supposed to be caused by an electric spark, at atmospheric pressure and a temperature of about 65 deg. F.

ACETYLENE—3 per cent. gas plus 97 per cent. air to 55 per cent. gas plus 45 per cent. air, or a range of 52 per cent. (one writer says 73 per cent. gas plus 27 per cent. air.)

BLAUGAS—4 per cent. gas plus 96 per cent. air to 8 per cent. gas plus 92 per cent. air, or a range of 4 per cent.

COAL GAS—6.5 per cent. gas plus 93.5 per cent. to 19.5 per cent. gas plus 80.5 per cent. air, or a range of 13 per cent.

DRIGAS—4 per cent. gas plus 96 per cent. air to 8 per cent. gas plus 92 per cent. air, or a range of 4 per cent.

HYDROGEN—10 per cent. gas plus 90 per cent. air to 66 per cent. gas plus 34 per cent. air, or a range of 56 per cent. (one writer says 6 per cent. plus 94 per cent. to 72 per cent. plus 28 per cent.)

THERMALENE—12 per cent. gas plus 88 per cent. air to 30 per cent. gas plus 70 per cent. air, or a range of 18 per cent.

The ignition temperatures of some of the gases, at atmospheric pressure are: Acetylene, 760 to 820 deg. F.; city gas, 1100 deg. F.; hydrogen, 1075 to 1100 deg. F.

According to McCormack, the cu.ft. per pound of gases was calculated for the specific gravity and found to be: Acetylene, 14.8 cu.ft.; coal gas, 24.3 cu.ft.; hydrogen, 192.4 cu.ft.; thermalene, 13.97 cu.ft.

THE FIELD OF GAS TORCH WELDING AND CUTTING

In a general way, the field of the gas torch welding and cutting may be outlined as follows, though some of the applications enumerated are more advantageously done by other methods. This is especially true with reference to the welding of heavy sections which should, as a rule, be done with thermit.

AEROPLANE CONSTRUCTION.—Welding water jackets to cylinder, valve cages to cylinder, of manifolds (intake, exhaust, and cooling), flanges to the manifold connections, spark plug thimbles, tubular sections for frame, splice plates, sockets to frames, aluminum crank cases, water tank.

AUTOMOBILE INDUSTRY.—Welding rear axle housings, defective gears and pinions, manifolds, shafts, steering posts, automobile bodies (aluminum and steel), tubing used in wind shields, etc., crank cases, transmission cases, wheels which are made of stamped-out parts, mufflers, valve stems to valves, rims, repairing crank shafts, frames, extending frame to make a truck out of a car.

COPPER PLATE.—Welding manifolds, flats, kettles, vats, tanks, copper, stills, and chemical ware.

ELECTRIC RAILWAY.—Welding of bonds, worn boxes, motor housings, building in teeth of defective pinions and gears, reclaiming of broken trucks, welding air receivers on air-brake system, steel trolley wires, side frames.

FORGE SHOP.—Welding ornamental iron, complicated parts.

FOUNDRIES.—Steel foundry: Welding up of blowholes, porous spots, blocks, cutting of risers, gates and heads; welding moldings which are cast in parts. Cast iron foundry: Reclaiming castings.

LEAD BURNING.—Burning of connectors on storage batteries, battery repairs, lead linings in vats, tanks, etc., lead-pipe joints.

PIPING AND GAS MAIN WORK.—Welding of steam, air, gas, oil, and water lines, welding for high pressure gas distribution, ammonia systems. Fittings, such as T's, Y's, S's, crosses, which are cut and welded on the job, meter connections for houses, traps, drip pots.

PLATE WELDING.—Ammonia receivers, generators, air receivers, tanks for oil, vacuum driers, digesters, vats, steam driers, tanks of all kinds which are to be subjected to heat and pressure, plate assembly work for gas manufacture by-products, recovery work, stills.

POWER PLANT MAINTENANCE.—Building up worn or broken parts, welding of cylinders, pistons, valve chests, etc. Welding of steam lines, of pump castings broken in service. Repairing of flywheels.

RAILROAD REPAIR.—Firebox repairs (including patches), replacing side sheets, welding in flues, cutting off rails, mud rings, welding cracked steam chest, valves, crossheads, cylinders, building up worn pins, cutting out links, irregular shapes of steel, filling worn spots on wheels, welding spokes, cutting and welding up locomotive frames. Welding together parts of car seats, chair and window frames. Reclaiming bolsters, couplings, slotting forged engine rods; building up frogs and diamond crossings, scrappings, building steel cars.

ROLLING MILL.—General repair of engines, rolls, hot beds, plates, furnace equipment, fabricating open-hearth water jacket doors, reclaiming copper tuyeres, cutting up lost heats, cutting up "kindling" or scrap, bar stock billets, plates.

SHEET METAL.—Manufacture of metallic furniture, steel barrels, transformer cases, range boilers, kitchen utensils, light air tanks, tubing, oil storage tanks.

SHIPYARDS.—Cutting of plates, channels, special sections, welding and reclaiming of broken parts of machinery and propellers, patching of hulls, stringers, building up of worn chocks.

SMALL ARMS MANUFACTURE.—Reclaiming component parts, spot hardening of different parts.

STRUCTURAL STEEL.—Cutting as applied to coping, splicing and fitting rails, channels, I beams and other shapes. Cutting holes for rivets, welding up misdrilled holes, cutting of all kinds of gusset splice plates, cutting wrecking, welding structural parts where riveting is not possible.

THE PRODUCTION OF WELDING GASES

Oxygen is a gas which constitutes about 23% by weight and 21% by volume of the air we breathe, most of the other percentage being nitrogen, a gas which does not support combustion. Oxygen itself will not burn, but it is the greatest supporter of combustion known. It was probably discovered by Stephen Hales in 1727, though Priestly was the first to publish a description of it in 1774. The name "oxygen" was later applied to the gas by Lavoisier. Pure oxygen is colorless, odorless

and tasteless. For welding work it is important that the oxygen used be as pure as it is commercially possible to obtain it. The impurities which decrease its efficiency are usually hydrogen and nitrogen.

There are three ways to produce oxygen commercially; by means of liquid air, by chemicals and by the electrolytic process. When oxygen is made by the liquid air process, there is a certain amount of nitrogen present. In the chemical methods, a number of impurities may cause trouble. By the electrolytic process, the impurity is hydrogen.

Oxygen by the Liquid Air Process

As a general rule, taking everything into consideration, it is far better for the average or small user to buy his oxygen from a reliable concern and not try to manufacture it himself. The oldest concern in this country making oxygen by the liquid air process, is the Linde Air Products Co., with offices in New York City. Their cylinders are regularly furnished in two sizes of 100 and 200 cu.ft. capacity respectively. They are charged to a pressure of 1800 lb. at a temperature of 70 deg. F. Customers are furnished cylinders free

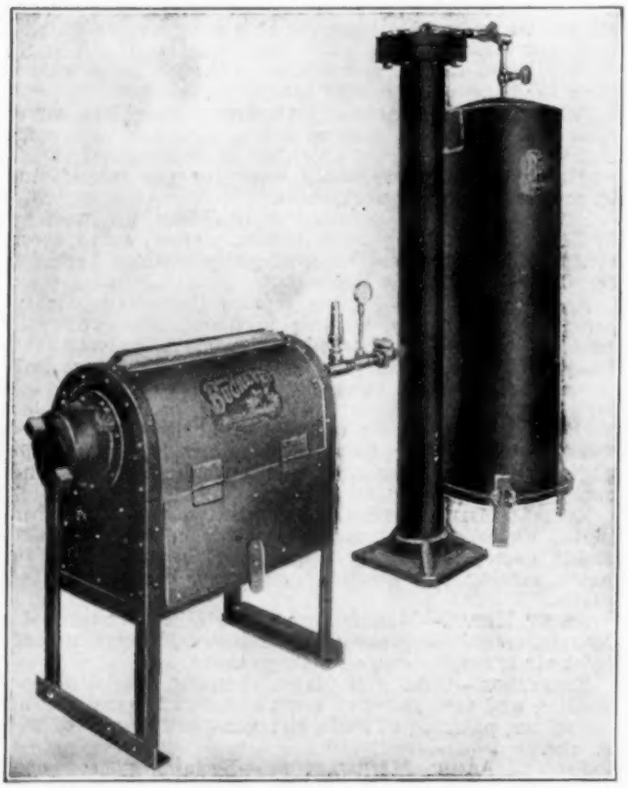


FIG. 86. THE BUCKEYE CHEMICAL OXYGEN GENERATING SET

and pay only for the oxygen. Empty loaned cylinders are exchangeable for filled ones at stations in practically every city of fair size in the country. A 50 ft. size of cylinder is obtainable for those whose requirements are very limited. A number of other concerns supply electrolytic oxygen for the market, the 100 cu.ft. cylinders being about 8½ in. in diameter and 48 in. high, weighing approximately 122 lb. when filled. The average purity of oxygen in cylinders is about 99%.

Since the production of oxygen by the liquid air process is only applicable to large installations any detailed description of the method would be out of place here. It is sufficient to say that in general, the process consists of first reducing the air to liquid form by means of the combined action of high compression and low temperature, and then separating the oxygen and nitrogen of which it is composed, by taking advantage of the different boiling points of the two. Under atmospheric pressure the boiling point of very pure liquid oxygen is —182.7 deg. C. (—296.9 deg. F.) and of very pure nitrogen—195.5 deg. C. (—319.9 deg. F.) This means a difference in the boiling points of 12.8 deg. C., or 23 deg. F. These respective boiling points will, of course, vary under different pressures, and various degrees of purity, but the difference between the two is sufficient to allow of the nitrogen being vaporized in suitable apparatus and carried away before the oxygen vaporizes.

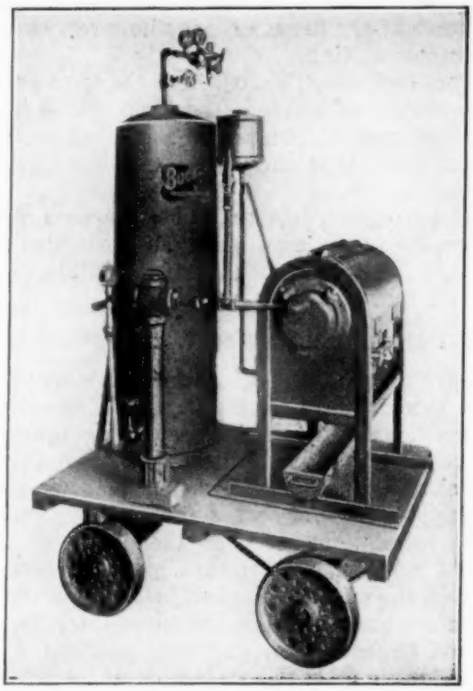


FIG. 87. BUCKEYE OXYGEN GENERATOR MOUNTED ON A TRUCK

Where circumstances make the chemical production of oxygen advisable, the chlorate of potash method is probably the most satisfactory at the present time. In this process chlorate of potash ($KClO_3$) and manganese dioxide (MnO_2) are mixed together in the proportion of 100 to 13 parts (about 8 to 1). This mixture is placed in a retort filled as full as possible to exclude air. The retort is then heated and the oxygen is driven off. As the oxygen gas passes off from the retort it is conveyed through a cylinder or vessel containing sodium hydroxide (NaOH) which removes most of the impurities. The oxygen is then piped to a gasometer from which it may be used direct or pumped into cylinders. A pound of the mixture is said to produce about 4 or 4½ cu.ft. of oxygen. The manganese dioxide is simply used to retard the release of the oxygen, which otherwise would be too rapid.

An oxygen generator working on the general principles just outlined, is made by the Macleod Co., Cincinnati, Ohio. This firm makes both a stationary and a portable type. A stationary type is shown in Fig. 86 and a portable one in Fig. 87. The generator, which consists of a furnace with retort, a scrubber for hold-

ing the purifying solution, and a receiver for the gas, is quite convenient for small shops or garages where a limited amount of oxygen is used. It is quite possible, however, to fill tanks from these generators for storage purposes and immediate use if needed. An oxygen generator may be used in conjunction with a cylinder of dissolved acetylene, or with a separate acetylene generator. Where portable generators are used for both oxygen and acetylene, it is advisable to have the outfits on separate trucks so as to decrease danger should any leaks develop.

The Buckeye generator is so made that it is adaptable to the use of wood, coal, coke or charcoal for fuel, or can be fitted with gas, gasoline, alcohol or oil burners. The portable type is shown fitted with a gasoline burner. The generators are tested to 2½ times the maximum working pressure of 300 lb. Safety devices are provided so that it is safe for practically unskilled tenders. These generators are made in three sizes, with a capacity of 40, 60 and 100 cu.ft. of oxygen per hour. The weight of the portable type will range around 650 lb. and of the larger stationary type about 1600 lb.

Improved Packing Methods for Carburizing

By WILLIAM H. ADDIS

Many times in carburizing operations small parts come out partly or imperfectly hardened, principally due to faulty spacing in packing. Two good methods of quickly spacing pieces are here described.

ONE of the most expensive factors in the carburizing of large quantities of small steel parts is that of packing the pieces to be carburized in pots filled with the carburizing compound. This class of work is generally done by girls. It is strictly an honor task, for after a pot is packed with parts and compound, there is no way to determine how thorough the packer's work has been without destroying her labor by dumping the pot's contents. For this reason piecework has never proved very successful, as there is a tendency to slight the careful uniform placing of each part in order to show a large number of pots packed.

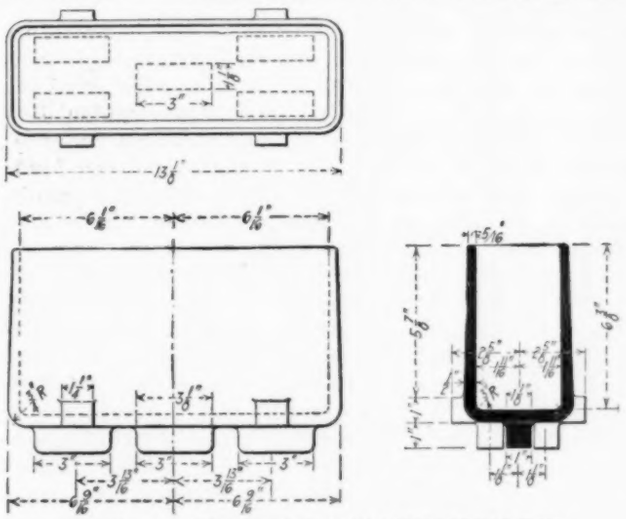


FIG. 1. A GOOD DESIGN OF CARBURIZING POT

Carburizing in pots is accomplished by using a cast-iron pot, preferably the hard white iron of the malleable grade before annealing. This casting does not scale away, swell and break down under continual firing and cooling, as does the gray-iron casting. A very good design of pot is shown in Fig. 1. This type is provided with base lugs on the bottom, which permit an even distribution of heat under the pot, and also having sturdy side lugs which serve the double purpose of keeping the pots spaced a uniform distance apart, and providing a suitable grip for the pot fork which is used in removing them from the furnace. These pots should be provided in standard sizes to suit the work in hand.

The carburizing compound, which is made up of a proper blend of charcoal, petroleum coke, barium carbonate, soda ash and ground bone, properly granulated, is sprinkled in the bottom of the pot to a depth of at least ½ in., and then the work is uniformly spaced, leaving room enough between each part for a portion of the compound. If the parts are permitted to touch in packing, the result will be either a burning of the parts at the point of contact or a failure to carburize, and sometimes both occur.

For the same reason the work should be kept ½ in. or more, according to size, from the sides and ends of the pot. Having placed the bottom layer of work in the pot it should in turn be covered with compound and the process of alternating work and compound be continued until the pot is filled within 1 in. of the top. The top layer of work must be covered with a generous layer of carburizer to prevent the shrinking of the pot contents when heated to a carburizing temperature of 1650 degrees F. as some compounds shrink so much that the top layer of work will be left exposed. After placing the top layer of carburizer the pot is ready to be sealed.

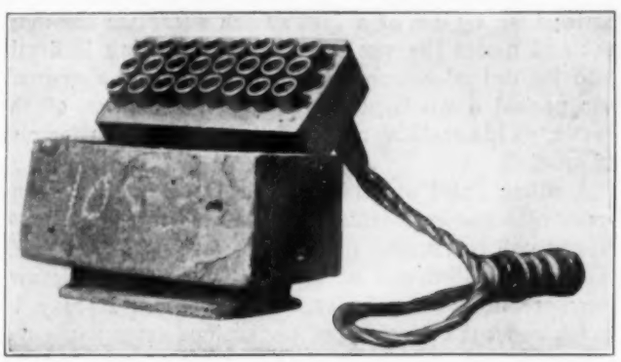


FIG. 2. MAGNETIC PACKING PLATE

In order to appreciate the importance of the simple operation of pot sealing we must consider the carburizing operation. After packing and sealing the pot it

is placed in the furnace and heated to a temperature approximating 1550-1700 deg. F. Within this range of temperature the outer surface of the steel parts in the pot have become so porous that the carbonaceous gases evolved within the sealed pot penetrate the steel. It is the degree of penetration that determines the depth of case. If the pot was improperly sealed and 20 per cent. of the gases evolved in the pot escaped there would be

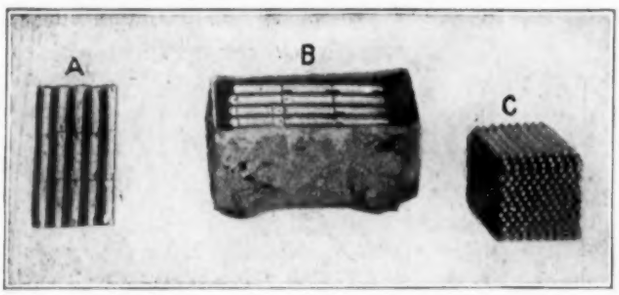


FIG. 3. CORRUGATED PAPER SPACERS

an evident loss in the efficiency of the carburizing agent and a corresponding lack of uniformity in the carburized work. . . . The most efficient seal that the writer has ever observed consists in placing on the top of the packed pot a ½-in. steel plate of such dimension that it will just fit inside the pot; the pot is then sealed by luting with a mixture of 1 lb. of coarse salt to 10 lb. of good fire clay generously applied. . . .

Improved Methods

It will readily be seen from the above detailed description of the ordinary methods of pot packing that there is an opportunity for improvement in the handling of large quantities of like pieces. One of the first ideas to be developed by the writer was the magnetic packing plate shown in Fig. 2. This chuck is so designed that the packer quickly spaces the parts to be packed on the plate; then by use of a foot switch energizes the magnet and places the work in the pot, pressing it firmly into its bed of compound, and, releasing the magnet, has packed a whole pot layer with one motion of the hands. This method makes for speed and uniformity of spacing.

Another novel and highly efficient way of packing small pins and cylindrical parts is illustrated in Fig. 3. Here small corrugated paper plates are used to provide the speedy alignment of parts. This paper is known commercially as single-faced corrugated. It may be purchased cut to inside pot dimensions from paper-box factories. At *A* is shown a paper plate containing 15 pins ½ in. in diameter and 2½ in. in length. Notice their regular spacing. At *B* is shown a like plate of pins in the pot ready for packing, while at *C* is pictured 17 plates packed with work and stacked until such a time as it will be convenient to place them in the pots. Again the uniformity of spacing is shown by the projecting ends of the pins. With the use of corrugated paper plates there is a doubling of packing-room production and a great improvement in the quality and uniformity of the work.

Both of these methods described here have the advantage of making the packer's work a lighter task, while they guarantee a uniformity of spacing and packing that makes it possible to place this class of work on a piecework basis by removing the only objection thereto—that of wilful neglect to properly fill and space the pots.

Reducing the Labor Turnover

By George E. Kuhne

In looking over his records, the employment manager finds there is a vacancy in the press department and, although the applicant for a job has had no previous experience in the line of press work, he is accepted and is assigned to a foot press. About 3 p.m. the foreman notices that the new operator is lagging, yet his work is all right. Next day the same thing happens, but the operator is a bit slower than before and the foreman mentions it to him. After lunch the operator says he would like to go home, explaining that he is not well. Permission is granted and that is the last seen of him. Another inexperienced man is hired, with a similar result.

Now the question arises as to what is the difficulty in the press department. The foreman intimates that the wrong men are being selected for the work; this entails strained relations between the employment manager and the foreman. The latter is a good fellow, conscientious, and a hard worker, but he does not realize that other things, seemingly insignificant, would prove to be of value if he would use them properly. When an inexperienced man is hired, it is a good plan for the foreman to explain to him the little aches and pains that are very usually attendant upon the beginner in such work.

An Instance Cited

In order to illustrate the value of such a procedure I will cite an instance of one week ago. A girl was assigned to a hand-milling machine, the job requiring the usual operations in the matter of manipulating levers and clamping the work. She was an experienced employee on other work, but on the second day I was notified that she desired a change of jobs or permission to go home, as she was not feeling well enough to continue. Investigation disclosed the fact that she had pains in the arms and shoulders, but when I explained that they were most likely due to the manipulation of levers, etc., to which she was unaccustomed and that a consultation with a doctor was in all probability not required, she consented to remain. A little later she said, "I guess you were right; the pains have all gone. I'll stay." She remained on the job for some days after that, apparently contented with her work and making no further complaint.

Such small matters as stated require little effort, and will oftentimes be of value in maintaining standards of production as well as preventing the loss of desirable help. It matters not what the duties are; it is well for each foreman to study the conditions under which they are performed and familiarize himself with their effect upon an inexperienced person. Thus he will put himself in a position to offer sympathy and advice at the right moment, and thereby hold an employee that he might otherwise lose. When a man is fatigued, he is literally "not himself"; his best efforts are not exerted, his "control ability" is lowered far more quickly than his ability to become angry, and he does not see things in the proper light.

Making Gun Sights for Anti-aircraft Guns

By Fred H. Colvin

The special fixtures used in connection with the main parts of these gun sights are full of suggestions for other purposes. They show the adaptability of the good mechanic, as without previous experience they made gun sights which not only passed all inspection, but were also made in record time.

WHEN it is considered how quickly the anti-aircraft gun must be handled in order to aim accurately at enemy aircraft, it is natural that the sighting mechanism must be very delicate and more or less complicated, as well as being capable of quick handling in various directions. Some idea of the problems involved in the manufacture of these sights may be had from a study of Fig. 1, which shows how universal the various movements must be. This is perhaps one of the most completely universal movements of any piece of mechanism of its size, and it involves an ingenious combination of slides and trunnions, as can be seen. Needless to say it requires very accurate work to bring these slides and trunnions into proper alignment to obtain the necessary movement in all directions. The sighting mechanism consists primarily of the yoke *A*, which is attached to the recoil cylinder at *B*. This allows the sight to be swung up and down on the gun by means of the curved rack *C*. This movement is governed by a worm-actuated pinion in the case *D*.

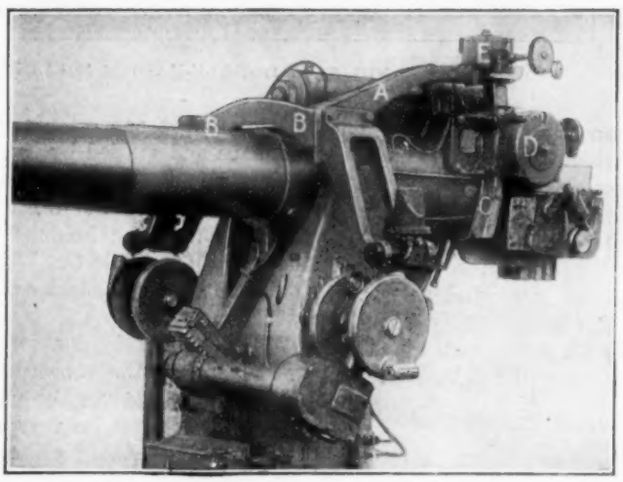


FIG. 1. THE SIGHT IN PLACE ON THE GUN

Cross-movement to allow for windage is had by a similar mechanism at *E*. In order to allow both these movements the connection between the yoke and the recoil cylinder is of special interest, being a combined slide and trunnion on one end and a hinged trunnion at the other. This is shown more in detail in Fig. 7 and 8. The main portion of the sight is the yoke, which is a steel casting, as shown in the foreground of Fig. 2. A similar yoke and a pile of these waiting to be laid out are shown on the other surface plate and on the floor behind it. The casting is painted with a cold-water paint to leave a

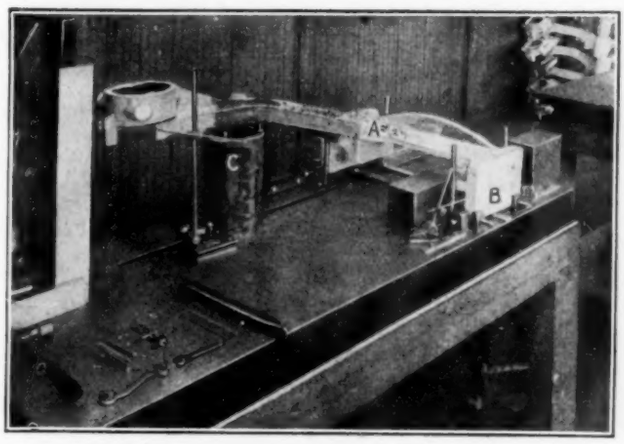


FIG. 2. LAYOUT BENCH ON THE YOKE

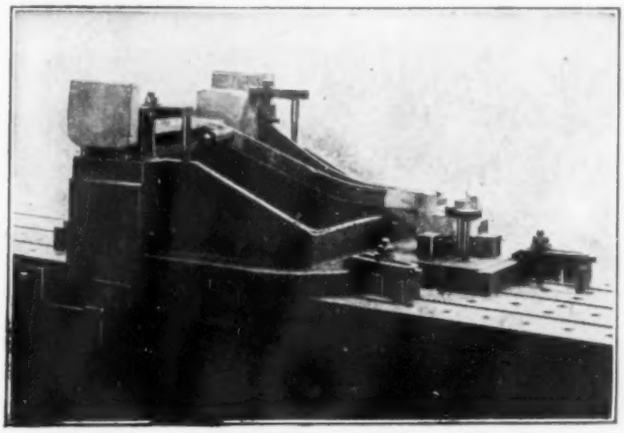


FIG. 3. PLANING BOTTOM OF PADS

good surface for scribing the various lines and locating the different points. The yoke is supported on the surface plate in its proper position, as shown at *A*, the seat, or pads, being located by means of the setscrews and block shown at *B*. The upper end is supported on the jack *C*, this being simply a cast-iron cylinder supplied with four setscrews and check nuts, which are easily handled. The first step is to see if the castings will clean up in all directions, there being a tendency for them to warp after coming out of the mold, in which case they are simply heated and straightened in much the same manner as malleable-iron castings. They are then laid out at the various points by means of surface gages, distance blocks and other devices. The first machining operation is to plane the bottom of the seat, or pads, to obtain a working surface for the operations which follow. The fixture in which this is done and the way in which the yoke is held are clearly shown in Fig. 3.

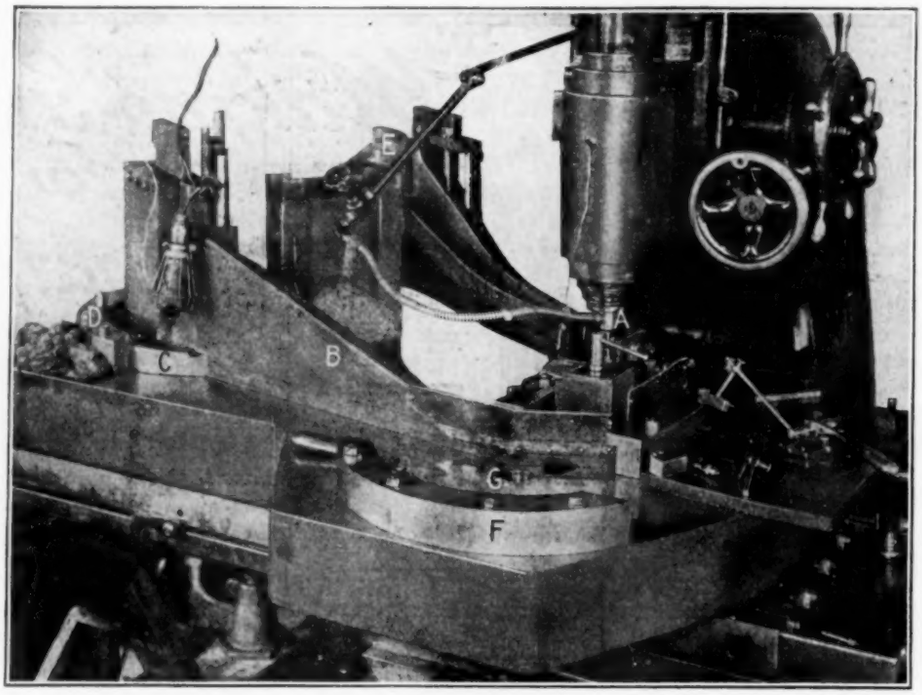


FIG. 5. A DOUBLE-RADIUS MILLING FIXTURE

The second planing operation is shown in Fig. 4, and is a double fixture in which the yokes are located on the steel strips at *A* and clamped at *B*, while the upper ends are held in position by the jaws and setscrews shown. The fixture makes it comparatively easy to handle these rather awkwardly shaped pieces, and they are machined in good time by means of the tools shown.

A Double Arc-Milling Fixture

The next specially interesting operation is that of milling the two arcs, one in the head and the other at the face of the yoke. These operations are performed in the fixture shown in Fig. 5. This fixture holds the yoke in the proper position by means of suitable clamps. In the position shown the long radius arc in the head is being milled at *A*, the body of the fixture *B* swinging from a fulcrum under the arc *C*. This portion of the fixture has a central pin, or fulcrum, and is also held in place and guided by the curved piece *D*.

For milling the other end, as may be seen at *E*, the fixture carrying the work is moved so that the arc *C* comes under the holding piece *F* and the center pin drops into the hole *G*. With the fixture in this position suitable milling cutters easily mill out the proper radius at *E*.

Details of this double fixture are given in Fig. 6, which shows the construction of the fixture and how the center pin gives the proper radius for the two arcs. These arcs must be very accurate, as the sights must move easily without either bind or shake. In order to be sure that this condition has been obtained the yokes are carefully tested in two positions. Fig. 7 shows the testing table for the long radius arc, the block *A* being substituted for the lugs on the recoil cylinder which hold the yoke in place on the gun. The yoke swings at *B* with relation to the block *A*, the arc at *C* allowing movement in a horizontal direction. The testing of the

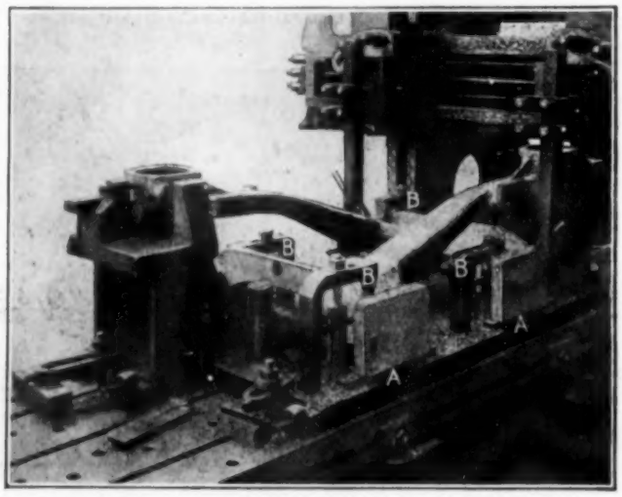


FIG. 4. A DOUBLE-PLANING FIXTURE

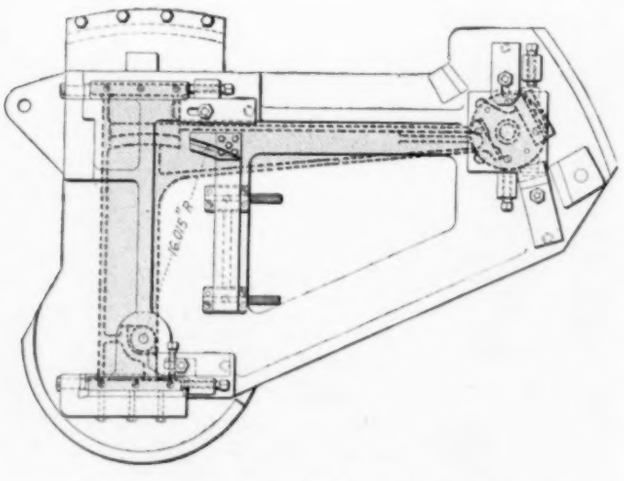


FIG. 6. DETAILS OF THE MILLING FIXTURE

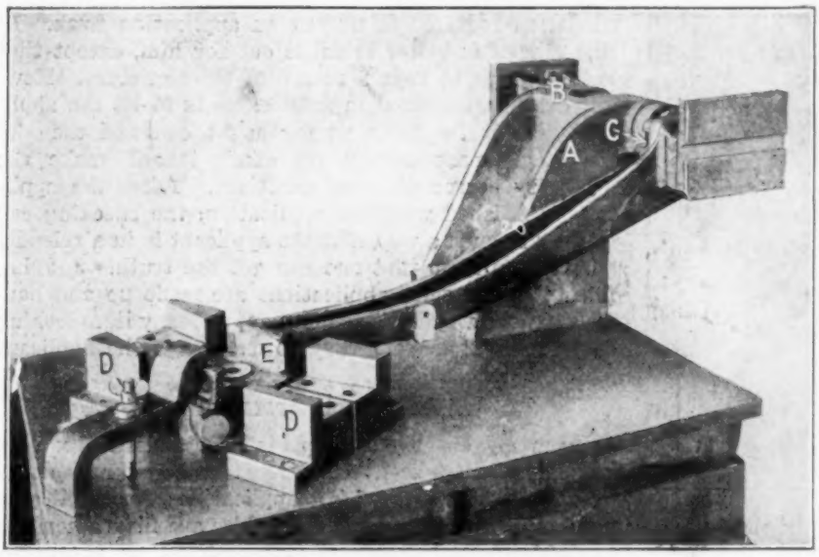


FIG. 7. TESTING THE LONG-ARM RADIUS

arc in the head is done by means of a templet or gage that is of the correct radius and which fits into the blocks *D* also of the proper radius. With the yoke clamped in the position shown, the curved block is moved through the hardened guide *D*, and it must show a good bearing in the curved end of the yoke at *E*.

guided past the milling cutters by means of the arc *C* and also a similar arc *D* at the front of the fixture. This can be used with either hand or power feed, the handle *E* being used in the former case. For power feed it is only necessary to connect up the geared shaft *F* shown at the other end of the table.

Another operation is the cutting of curved racks, which is done by a special fixture on a Fellows gear-shaping machine as shown in Fig. 10. This fixture cuts the piece on the outside of the arc at *A* in Fig. 9, although the work shown in position in Fig. 10 is on the inside of the

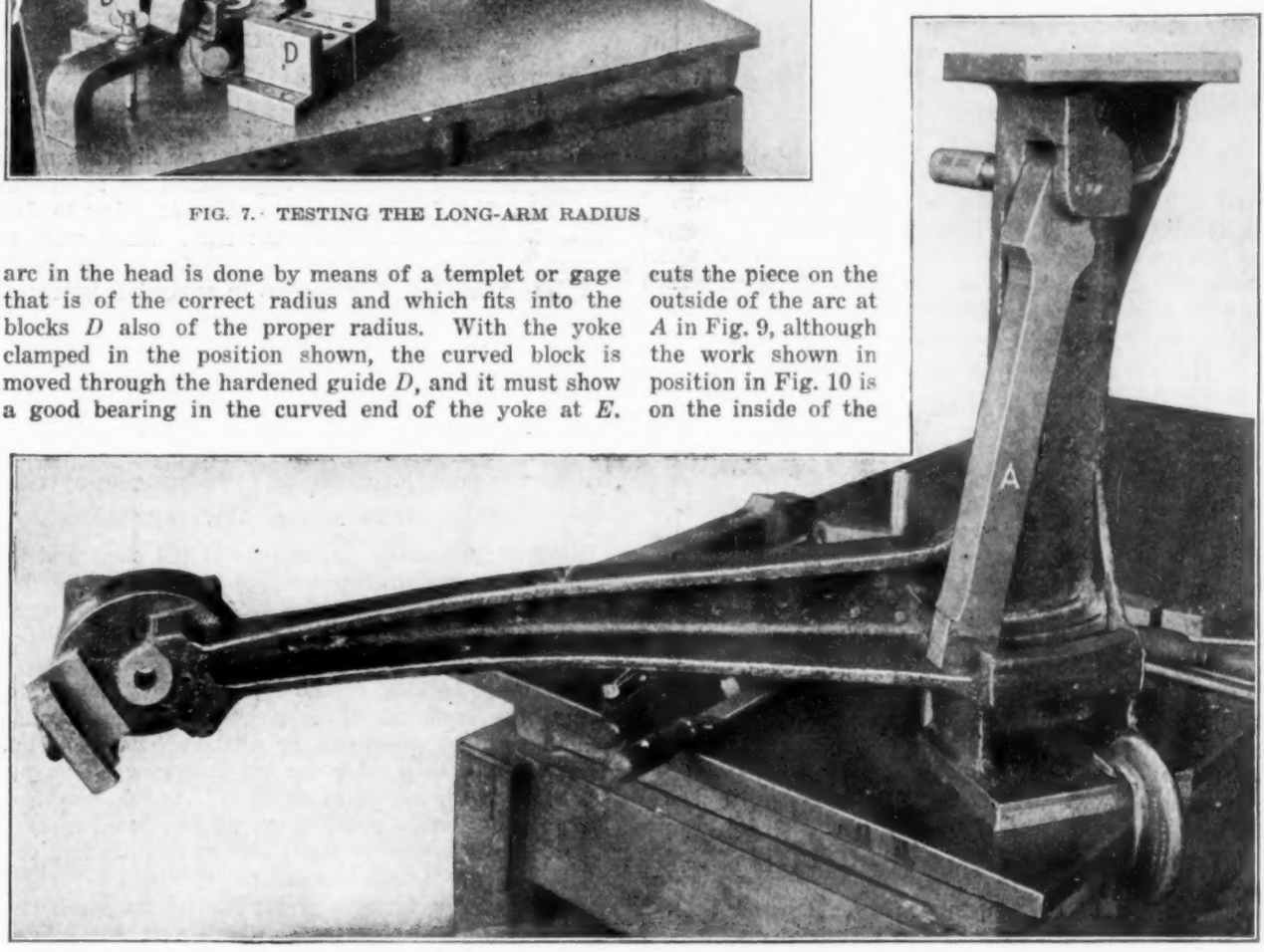


FIG. 8. TESTING THE CROSS-ARM RADIUS

Final fitting in this is done by an expert scraper, so as to get the exact fit desired.

A similar method is shown in Fig. 8, where the other arc is being tested by means of the bar *A*. Here also is shown the care that must be exercised in obtaining the proper fit besides giving another view of the yoke and emphasizing its awkward shape.

The Sight Bar

Another piece in connection with the sighting mechanism is the sight bar, one of them being shown at *A*, Fig. 9. These are steel forgings, as may be seen, and are also rather awkward in shape. The operation shown is the surfacing and shaping of the curved base *B*, while the forging is held in the special fixture shown on the milling machine. The illustration needs little explanation, as it may readily be seen how the work is

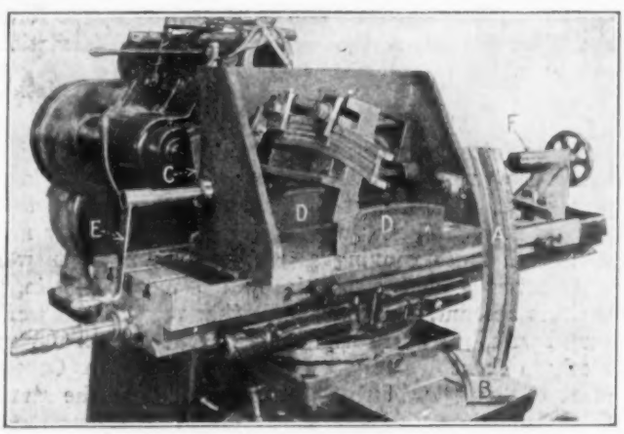


FIG. 9. A CURVED MILLING FIXTURE

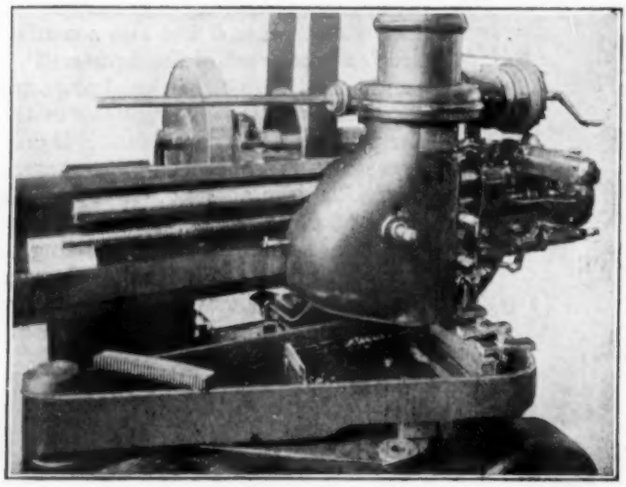


FIG. 10. CUTTING A CURVED RACK

curve. This fixture consists principally of the segmental table hinged at the left hand end, which is so located as to give the proper radius for the arc to be cut. The plate or table is supported by a slide directly beneath the cut so as to avoid all tendency to spring under the cut.

How to Handle an Employment Department

By A. J. Schneider
Employment Manager, Cincinnati Planer Co., Cincinnati, Ohio

In an employment department a good application blank, properly used, is very important. The employment department is under a positive handicap unless the application blank is right. In drawing up the application form, it is necessary to consider: Questions and answers, standard size of form, how to use it, and method of filing for quick and accurate reference.

It is impossible to make up a standard application blank that will work well in every employment department. The employment department in a machine shop, for example, is doing very well if it succeeds in making up one standard form that can be used in classifying and hiring help for every department of the organization. For instance if the same form can be used in connection with the Planer Department as for the Drafting Department, it must be a good one. However, the information in both cases need not be the same, because the form can be so drawn that the information can be written on one form that would not be written on the other. In other words, the form should be flexible, so that special or extra information can be added to suit particular requirements.

The Application Forms

To go into every detail as to just what information should be printed on the form would require a long discussion. It is a question how far to go with this printed form. The average applicant feels uneasy and as though he is running a gantlet if he must answer systematically and mechanically too many questions. On this account, I would handle that part of the work very carefully. Some applicants fill out our form very nicely in about five minutes without any trouble. Others start to struggle, blush or grumble right at the start. With the latter, I simply say: "Just fill in your name and I will finish the card for you." For some jobs we have it is not so important for a man to have the education required to fill out an application form. In this case it is better to fill it out for him, except that it is of value to have a record of the signature. However, the best method in most cases is to let the applicant fill out the form as far as he can and then let the employment department check it and make the necessary corrections and additions. After the applicant is finished with the application, the checking can be done in such a way that the applicant is in a friendly state of mind so that one can get the truth. Judging from the way some applications are made up and handled, it is no wonder that there are so many liars looking for a job. It is very easy to encourage the applicant to tell a lie.

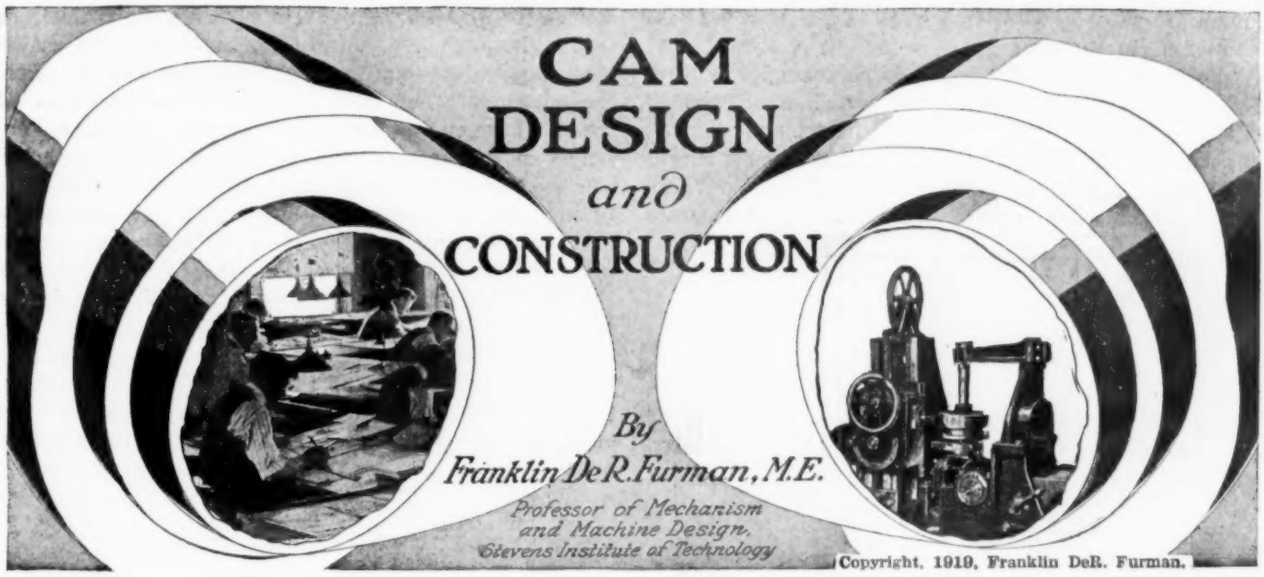
Filing the Application

From my experience, I prefer a standard 5 x 7-in. card, as the applicant can see it well and has plenty of space for writing. All applications for applicants not hired, but considered desirable, are filed according to occupation by date. The applications for applicants hired are filed in alphabetical order according to first letter in last name, and by the date. Each card, of course, is properly indexed.

We have had so little success in analyzing letters of application that we usually pick out the best looking letters and ask the applicant to call for an interview. In other words, we do the work face to face. We have hired several applicants by mail, where all the correspondence seemed ideal, and the results were poor. I don't know of any rules to use in analyzing letters, we try to use good judgment by considering everything.

Interviewing the Applicant

Next to the general appearance of the plant and the employment department, the applicant gets the first impression from the interview. Surely we all agree that this is important and must be done right. One thing that should be accomplished in the interview is the careful checking of the information given on the application card, which is given wrong intentionally sometimes, and sometimes by mistake. An important feature is the time taken for the interview. It is just as bad to hurry an interview as it is to take too much time. It is hardly possible except in special cases to conduct an interview in less than ten minutes and very seldom should it take one hour. If I had my choice of the two evils, I would prefer to give too much time rather than not enough. The time required depends upon the applicant and the occupation. I prefer to interview on foot, that is, I prefer to stand with the applicant. I would never let the applicant stand while I am seated. Both should stand or be seated. The standard job analysis should be used, if there is one. The applicant if hired should always be given a "Rule and Information Book," to take home. It is hardly possible to explain every detail during the interview, therefore, this book will be of great assistance to avoid misunderstandings and help the applicant to get started right. The rate of pay whenever possible should be given during interview and the possible future should be explained conservatively. The entire interview should be void of exaggeration, loud talking and many promises so that the applicant leaves with the feeling that he has just the right job and that he is the right man for it Remember all during the interview that you are playing a two-handed game and give the applicant lots of opportunity to ask questions, in fact, encourage him to do so.



II. Formulas and Factors

This installment contains the simpler formulas and factors that are the basis of this series of articles, and which enable the cam designer to know in advance exactly how large to make any of the simpler cams in common use so that they will operate with known maximum pressure angles, or, in other words, that they will not run hard or bind. Various terms necessary to use in the application of these formulas and factors are introduced and defined. A method of constructing and charting each of the base curves in common use and for locating the essential pitch line with reference to the base curve is also given.

CAM chart (Fig.14). The chart is a rectangle the height of which is equal to the total motion of the follower in one direction, and the length equal to the circumference of the pitch circle of the cam, both laid off accurately to scale. The chart length represents

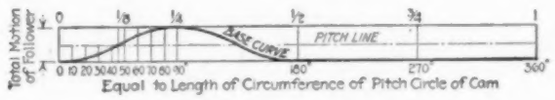


FIG. 14. CAM CHART

360 deg. and is sub-divided into equal parts marking the 5 deg., 10 deg. . . . points, or the $\frac{1}{8}$, $\frac{1}{4}$ . . . points, or any other convenient subdivision, according to the requirements of the problem. On the cam chart are drawn the base curve and the pitch line. The former becomes the pitch surface of the cam and the latter the pitch circle.

Cam-chart diagram (Fig. 15). The cam-chart diagram is a rectangle, the height of which represents the total motion of the follower in one direction. The length of the diagram represents the circumference of the pitch circle of the cam. In the cam-chart diagram the scales for drawing the height and the length of the rectangle are totally independent of each other and independent also of the scale of the cam drawing. In drawing the diagram no scale need be used at all, and the entire chart diagram with its base curve and pitch line may be drawn entirely freehand with suitable subdivisions marked off entirely by eye according to the requirements of the problem. The base curve may be

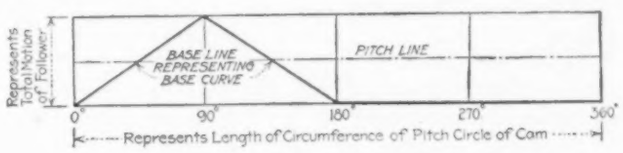


FIG. 15. CAM-CHART DIAGRAM

drawn roughly as a curve or it may be made up of a series of straight lines. The cam-chart diagram frequently serves all the purposes of the cam chart, especially in a preliminary study of the problem. It saves time and permits of chart drawings being made on small available sheets of paper, whereas the more precise cam chart often requires large sheets of paper which are impracticable and unnecessary in many circumstances.

Time charts (Figs. 16 and 17). Time charts are the same as cam charts or cam-chart diagrams and are constructed in the same way as described in the two pre-

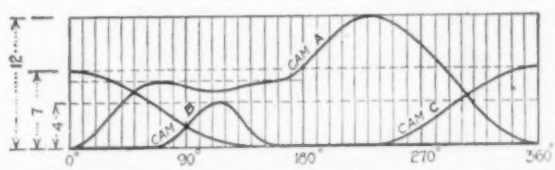


FIG. 16. TIME-CHART DIAGRAM, BASE CURVES SUPERPOSED

ceding paragraphs. The term time chart, however, is most appropriately applied to problems where two or more cams are used in the same machine and where their functions are dependent on each other. The time chart permits of allowances being made for avoiding possible interference of the several moving parts and for the desired timing of relative motions for each part. The time chart contains two or more base curves according to the number of cams used. When the base

curves are superposed as in Fig. 16 the time chart consists of a single rectangle whose height is equal to the greatest follower motion. The superposing of curves and lines often leads to confusion and error, and in general it is better that the time chart should consist of a series of charts or rectangles all of the same length and one directly under the other as in Fig. 17. Where there are many base curves it is desirable to separate

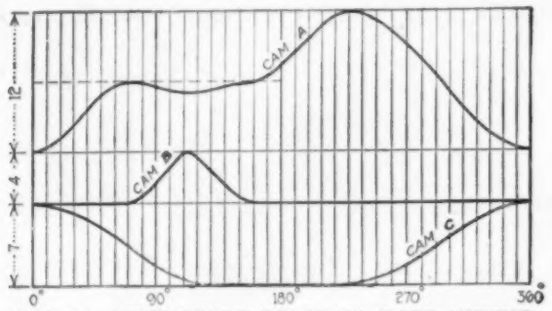


FIG. 17. TIME-CHART DIAGRAM, BASE CURVES SEPARATED

the rectangles by a small space to avoid any possibility of confusion due to different base curves running together. In many cases the term time chart diagram or timing diagram, will be more appropriate than time chart in the same way as the cam-chart diagram is more appropriate than the cam chart.

Base curve (Fig. 14). A base curve is made up of a series of smooth continuous curves or a combination of curves and straight lines, which represent the motion of the follower and which run in a wave-like form across the entire length of the cam chart or diagram. The base curve of the cam chart becomes the pitch surface of the cam.

Base line (Fig. 15). A base line is made up of a series of inclined straight lines or a series of inclined and horizontal lines in consecutive order, which zigzag across the entire length of the chart. The base line when used on the cam chart indicates the exact motion

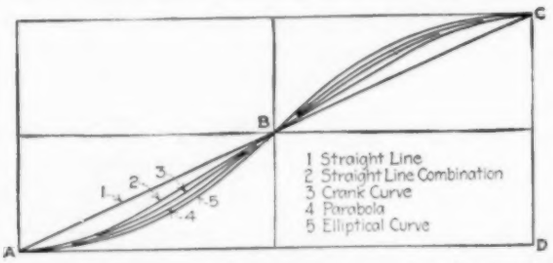


FIG. 18. COMPARISON OF BASE CURVES IN COMMON USE SHOWING VARYING DEGREES OF MAXIMUM SLOPE WHEN DRAWN IN SAME CHART LENGTH

of the follower, but when used on a cam-chart diagram it is merely a time-saving substitute for the drawing of the base curve.

Names of base curves or base lines in common use (see Figs. 18 and 19): (1) Straight line, (2) straight-line combination, (3) crank curve, (4) parabola, (5) elliptical curve.

Pitch line (Fig. 14). A pitch line is a horizontal line drawn on the cam chart or diagram, and it becomes the pitch circle of the cam. The position, or elevation, of the pitch line on the chart varies according to the base curve which is specified and according to the data of the problem. For cams which give a continuous motion to the follower during its entire stroke, or throw, the pitch line will pass through the point on the base curve which has the greatest slope, starting from the bottom of the chart. This does not apply to all possible base curves, but it does apply to all those mentioned in the preceding paragraph, a minor exception being made of the crank curve, which will be referred to in a later installment. When the cam causes the follower to move through its total stroke in two or more separate steps the position of the pitch line on the chart must be specially found, as will be explained later in problem 5.

Pitch circle (Fig. 20). A pitch circle is drawn with the center of rotation of the cam as a center and its circumference is equal to the cam-chart length. Its characteristic is that it passes through that point *A*,

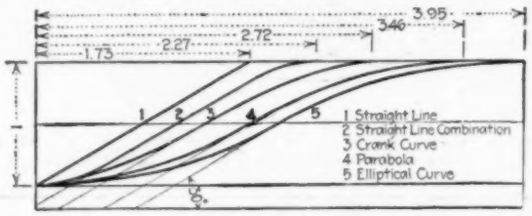


FIG. 19. COMPARISON OF BASE CURVES IN COMMON USE SHOWING UNIFORM MAXIMUM SLOPE OF 30 DEG. WHEN DRAWN IN CHARTS OF VARYING LENGTH

Fig. 20, of the pitch surface of the cam where the cam has its greatest side pressure against the follower. This applies to single-step cams in which the center of the follower roller moves in a straight radial line. For other motions of the follower roller and for flat-

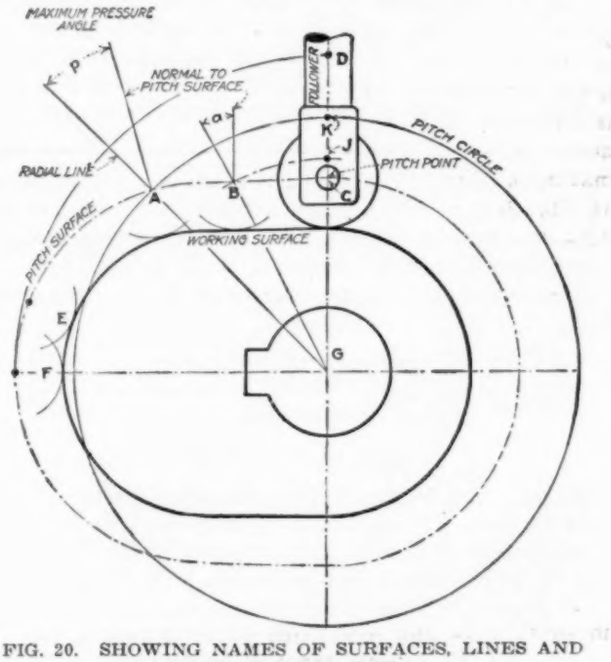


FIG. 20. SHOWING NAMES OF SURFACES, LINES AND POINTS OF A CAM

faced followers the pitch circle must be specially considered, as will be explained in some of the later problems covering these types.

Pitch surface (Fig. 20). The pitch surface of a cam is the theoretical boundary of the cam that is first laid down in constructing the cam. When the follower has a V-shaped edge the pitch surface coincides with

the working surface of the cam. When the follower has roller contact, as in Fig. 20, the pitch surface passes through the axis of the roller and the working or actual surface of the cam is parallel to the pitch surface and a distance from it equal to the radius of the roller.

Working surface (Fig. 20). The working surface of the cam is the surface with which the follower is in actual contact. It limits the working size and weight of cam. For exact compliance with a given set of cam data the cam has only one theoretical size which is bounded by the pitch surface, but the working size may be anything within wide limits which depend on the radius of the follower roller and the necessary diameter of the cam shaft.

The working surface is found by taking a compass set to the radius of the roller and striking a series of arcs whose centers are on the pitch surface. Such a series of arcs is shown in Fig. 20 with their centers at *B*, *A*, etc. The curve, which is an envelope to these arcs is the working surface.

Pitch point (Fig. 20). The pitch point of the follower is that point fixed on the follower rod or arm which is always in theoretical contact with the pitch surface of the cam. If the follower has a sharp V-edge the pitch point is the edge itself. If the follower has a roller end the pitch point is the axis of the roller. The pitch point is constantly changing its position from *C* to *D* as the follower moves up and down.

Pressure angle (Fig. 20). The pressure angle is the angle whose vertex is at the pitch point of the follower in its successive positions and whose sides are the direction of motion of the pitch point and the normal to the pitch surface.

Pressure angles exist when the surface of the cam presses sidewise against the follower; they cause bending in the follower arm and side pressure in the follower guide and in the bearings. The pressure angle is constantly varying in nearly all cams as the follower moves up and down. In assigning cam problems the maximum permissible pressure angle is usually given. In Fig. 20 the pressure angle is zero at *C*; it will be equal to a when *B* reaches *J*, and it will be a maximum when *A* reaches *K*.

The radius of the pitch circle of the cam may be found directly by the formula:

$$r = h \times \frac{360}{b} \times f \times \frac{1}{2\pi}$$

$$= 57.3 \frac{hf}{b} \qquad (1)$$

or, by the formula

$$r = h \times \frac{1}{e} \times f \times \frac{1}{2\pi}$$

$$= 0.159 \frac{hf}{e} \qquad (2)$$

in which r = radius of pitch circle of cam.
h = distance traveled by follower.
f = factor for a given maximum pressure angle.
b = angle, in degrees, turned by cam while follower moves distance h.
e = angle, in fraction of revolution, turned by cam while follower moves distance h.

The above formulas may be stated in words by rearranging, No. (1), for example, as follows:

$$r \times 2\pi \times \frac{b}{360} = h f$$

and saying that the necessary length of arc of the pitch circle for a given follower motion is equal to the follower motion multiplied by a suitable factor.

Factors have been determined for the base curves already mentioned and for a wide range of pressure angles, and are given below. Some of these factors will be used presently in constructing base curves, and the above formulas will be applied in the problems that will be taken up.

Cam Factors for Maximum Pressure Angle

The factors, or value, of f for various maximum-pressure angles for cams using the several base curves in common use are:

TABLE OF CAM FACTORS

Name of Base Curve	Maximum Pressure Angle and Values of f 20°	30°	40°	50°	60°
Straight line	2.75	1.73	1.19	0.84	0.58
Straight-line combination *	3.10	2.27	1.92	1.77	1.73
Crank curve	4.32	2.72	1.87	1.32	0.91
Parabola	5.50	3.46	2.38	1.68	1.15
Elliptical curve †	6.25	3.95	2.75	1.95	1.35

* For case where easing off radius equals follower's motion.
† For case where ratio of horizontal to vertical axes of ellipse is 7 to 4.

These factors for 30 deg. are illustrated in Fig. 19 where each of the base curves is given such a length, in terms of the height, that they will all have the same maximum slope. The values given in this table are

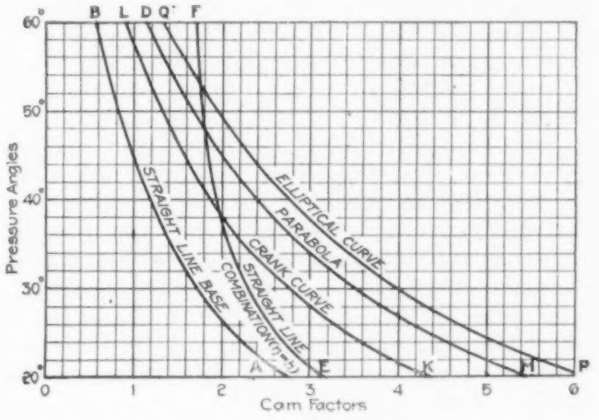


FIG. 21. CHART SHOWING RELATION BETWEEN PRESSURE ANGLES AND CAM FACTORS FOR THE ORDINARY BASE CURVES

also shown graphically in Fig. 21, thus enabling one to find the proper cam factor for any intermediate pressure angle between 20 deg. and 60 deg. The methods of determining the cam factors are involved in some instances and will be given in one of the later installments dealing with more advanced work.

Method of Construction of Base Curves in Common Use

Detail construction of base curves. The method of constructing the several base curves for a rise of 1 unit of the follower will be explained in the succeeding paragraphs. The curves will be constructed to give a maximum pressure angle of 30 deg. by selecting factors from the 30 deg. column in the above table of cam factors.

Straight-line base (Fig. 22). Lay off *A B* equal to the follower motion, which will be taken as 1 unit in

these illustrations. Multiply this by the factor 1.73 from the table of factors, and lay off the distance *A R* equal to the product. Complete the parallelogram and draw the diagonal. This will be the straight-line base and the angle *R A C* will be 30 deg. *A R* will be the pitch line. In this illustration and those that follow the base lines and curves will be laid off from right to left so that they may be used in a natural manner later on in laying out the cam so that it will turn in a right-handed or clock-wise direction.

The straight-line base gives abrupt starting and stopping velocities at the beginning and end of the stroke and causes actual shock in the follower arm. The velocity of the follower during the stroke is con-

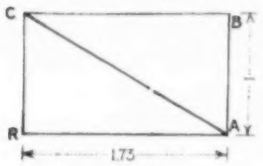


FIG. 22

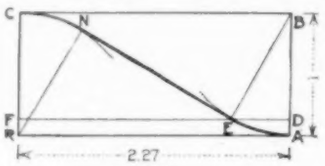


FIG. 23

FIG. 22. STRAIGHT BASE LINE

FIG. 23. STRAIGHT-LINE COMBINATION CURVE

stant. The acceleration at starting and retardation at stopping is infinite and is zero during the stroke.

Straight-line combination curve (Fig. 23). Construct the rectangle with a height of 1 unit and a length of 2.27 units. With *B* and *R* as centers draw the arcs *A E* and *C N* and draw a straight line *E N* tangent to them. The angle *F E N* will then equal 30 deg. and the line *A C* will be a base curve made up of arcs and a straight line combined to form a smooth curve. *D F* will be the pitch line.

The straight-line combination curve, being rounded off at the ends, does not give actual shock to the follower at starting and stopping, but it does give a more sudden action than any of the base curves which follow, and the maximum acceleration and retardation values are comparatively larger.

Crank curve (Fig. 24). Construct the rectangle in the same general manner as explained in the two previous cases. Draw the semicircle *R G C* and divide it into

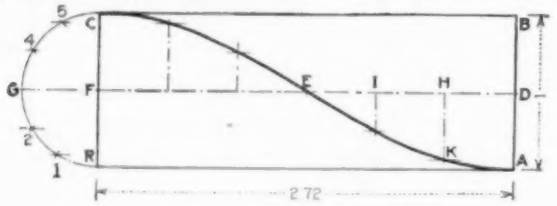


FIG. 24. CRANK CURVE

any number of equal parts. Six parts are best for practice work for this curve, but in general in practical work the greater the number of divisions the more accurate will be the curve and the smoother the action of the cam. The six equal divisions of the semicircle are readily obtained by taking *G* as a center and *F C* as a radius and striking arcs at *1* and *5*, then with *R* and *C* as centers mark the points *2* and *4* respectively. Divide the length of the chart into six equal parts, as at *H, I, E,* etc. From these points drop vertical lines, and from the corresponding divisions on the semicircle draw horizontal lines, giving intersecting points, as at *K*, on the desired crank curve. The tangent to the curve at *E* will then make an angle of 30 deg. with the line *E F*. The pitch line will be *D F*.

When the crank curve is transferred from the chart to the cam it gives an angle which is a fraction of a degree greater than 30 deg. at the point *E* on the cam in practical cases. This is not enough greater to warrant the special computations and drawing that would be necessary to be exact. Therefore the method of laying out the crank curve and the pitch line, as given above, will be adhered to in this elementary consideration of cam work because of its simplicity.

The crank curve gives a slightly irregular increasing velocity to the follower from the beginning to the middle of its stroke; then a decreasing velocity in reverse order to the end of the stroke. The acceleration diminishes to zero at the middle of the stroke and then the retardation effect increases to the end. The maximum acceleration and retardation values are much less than for the straight-line combination curve and are only a little greater than for the parabola.

Parabola (Fig. 25). Construct the rectangle as for previous base curves. Draw the straight line *R S* in

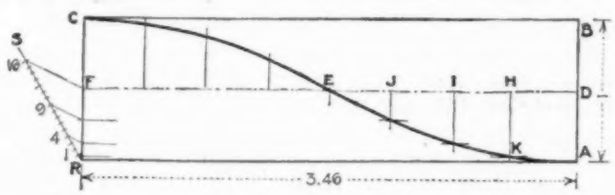


FIG. 25. PARABOLA

any direction and lay off on it 16 equal divisions to any scale. From the sixteenth division draw a line to *F*, the middle point of the chart; draw other lines parallel to this through the points *9*, *4* and *1*, thus dividing the distance *R F* into four unequal parts which are to each other in order, as *1*, *3*, *5* and *7*. From these division points draw horizontal lines, and from *H*, *I* and *J* drop vertical lines. The intersecting points, as at *K*, will be on the desired parabola. The points *H*, *I* and *J* divide the distance *D E* into four equal parts.

Requires Less Direct Effort

The parabola gives a uniformly increasing velocity from the beginning to the middle of the stroke; then a uniformly decreasing velocity to the end. The acceleration of the follower is constant during the first half of the stroke and the retardation is constant during the last half. The acceleration and retardation values are equal and are less than the maximum value of any of the other base curves. This means that the direct effort required to drive a parabola cam is less than for any other type of cam.

To better understand the smooth action given by the cam using this curve consider, first, *D H* as a time unit during which the follower rises one space unit; second, *H I* as an equal time unit during which the follower rises three space units; third, *I J* as the time unit during which the follower rises five space units, etc. Inasmuch as the follower travels two units further in each succeeding time unit it gains a velocity of two units in each time unit, and this is uniform acceleration.

The distance from *F* to *C* would be divided the same as from *F* to *R* and points on the part of the curve from E to C similarly located. The curve *E C* will be iden-

tical with *E A*, but in reverse order, and will give uniform retardation. The tangent to the curve *A C* at the point *E* will make an angle of 30 deg. with *E F*, and *D F* will be the pitch line.

Eight construction points were taken in developing the curve *A C*. Eight points will be sufficient for beginners for practice work, and later six points may be used. When using six points only nine equal divisions should be laid out on the line *R S*, the remaining construction being the same as described above, except that *D E* should be divided into three parts instead of four. In practical work many more construction points should be used for accuracy and smooth cam action.

Elliptical curve (Fig. 26). Draw rectangle *A B C R* as in previous cases. Draw semi-ellipse making *F G* equal to 7/4 *F C*. To draw the ellipse take a strip of

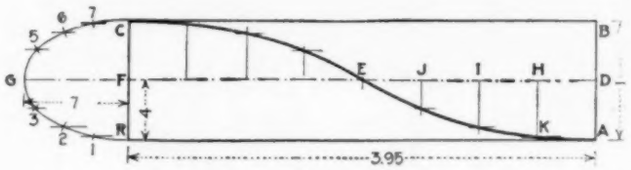
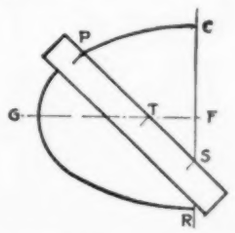


FIG. 26. ELLIPTICAL CURVE
FIG. 26A. SHOWING METHOD OF DRAWING SEMI-ELLIPSE



paper with a straight edge and mark fine lines at *P*, *T* and *S*, Fig. 26a, making *P T* = *C F* and *P S* = *G F*. Move the strip of paper so that *S* will always be on the line *R C* and *T* on the line *F G*; *P* will then describe the path of the ellipse. Having the semi-ellipse, divide the part *R G*, Fig. 26, into four equal arc lengths as at *1*, *2*, *3*. This is quickest done by setting the small dividers to a small space of any value and stepping off the distance from *R* to *G*. Suppose that there are 18.8 steps. Set down this number and divide it into four parts, giving 4.7, 9.4 and 14.1. Then again step off the arc from *R* to *G* with the same setting of the dividers, marking the points that are at 4.7, 9.4 and 14.1 steps. The compass setting being small, the fractional part of it can be estimated with all necessary practical precision. If greater accuracy is desired it may be obtained by setting the dividers by trial so that the quadrant *R G* may be stepped off into a whole number of steps such as 12, 16, etc., and then every third or fourth step taken as a construction point. Divide *D E* into four equal parts as at *H*, *I*, *J*. Draw vertical lines from these points and horizontal lines from the corresponding points at *1*, *2* and *3*. The intersections, as at *K*, will give a series of points on the elliptical base curve. The curve *E C* is similar to *E A* but in reverse order. The tangent to the curve at *E* makes an angle of 30 deg. with *E F* and *D F* is the pitch line.

The elliptical base curve gives slower starting and stopping velocities to the follower than any of the other curves, but the velocity is higher at the center of the stroke. The acceleration is variable and increases to the middle of the stroke, where its maximum value is greater than that of the crank but less than that of the straight-line combination curve. The retardation values decrease in reverse order to the end of the stroke.

Translating Drawings from Metric to English Measurement

By Dr. C. P. Schwarz

Sometimes it is necessary to translate metric dimension drawings into fractional inch drawings, or vice versa. Incidentally different standards for pipes, bolts, threads, etc., are incorporated so that ultimately the two designs are not interchangeable. The customary way is to look up the dimension in a conversion table and clutter up the drawings with a mass of superfluous and absurd decimals.

If we establish the arbitrary rule that 1 in. shall equal 24 mm., all sixteenths may be expressed in millimeters and only one decimal place is involved. Now, 4 in. = 101.6 mm., while we made 4 in. = 96 mm.; accordingly the metric version of the designer's pipe-dream has shrunk 4½ per cent. This is generally quite harmless but is eminently useful as it eliminates a great deal of figuring.

Gears of which the center distances have been translated in the above fashion will work out with metric (module) cutter with very little trouble. Take, for instance, two gears of 4 pitch with 14 and 19 teeth; the first has a pitch diameter of 3½ in. and the latter 4¾ in. and the center distance is 4⅛ in.

According to our way of figuring 4⅛ in. = 99 mm. To get the module we divide, 2 × 99, by the sum of the teeth, thus: $\frac{2 \times 99}{33} = 6$. The metric gears will thus figure out to be 6 × 14 = 84 mm., and 6 × 19 = 114 mm., and the center distance $\frac{84 + 114}{2} = 99$ mm.

Now you may take the American Machinists' Handbook and look up the table comparing the pitch and module cutters or gears and you will see that the translated gear is just as strong—for all practical purposes—as the original gear. This example is not doped out, it was picked at random, but if you have 7-pitch gears, you may not get results at the first shot. This scheme is also friendly to metric bolt sizes as they increase by 3 mm. To proceed in the reverse direction two rules may be selected from. The first, 25 mm. = 1 in., gives all even millimeters in two decimals; the design shrinks less than 1 per cent. but involves the use of unwieldy decimals.

The second, 24 mm. = 1 in., gives all millimeters which are multiples of 1½ in. sixteenths and the design swells about 5 per cent.; for instance: 419 mm. is not a multiple of 1.5, the figure nearest to it is 418.5 = $17\frac{7}{16}$ in. and the error introduced if the latter figure is taken is perhaps not sufficient to throw the design out of plumb.

Needless to say, the above way of figuring applies best when a design has to be adapted without attempt at interchangeability.

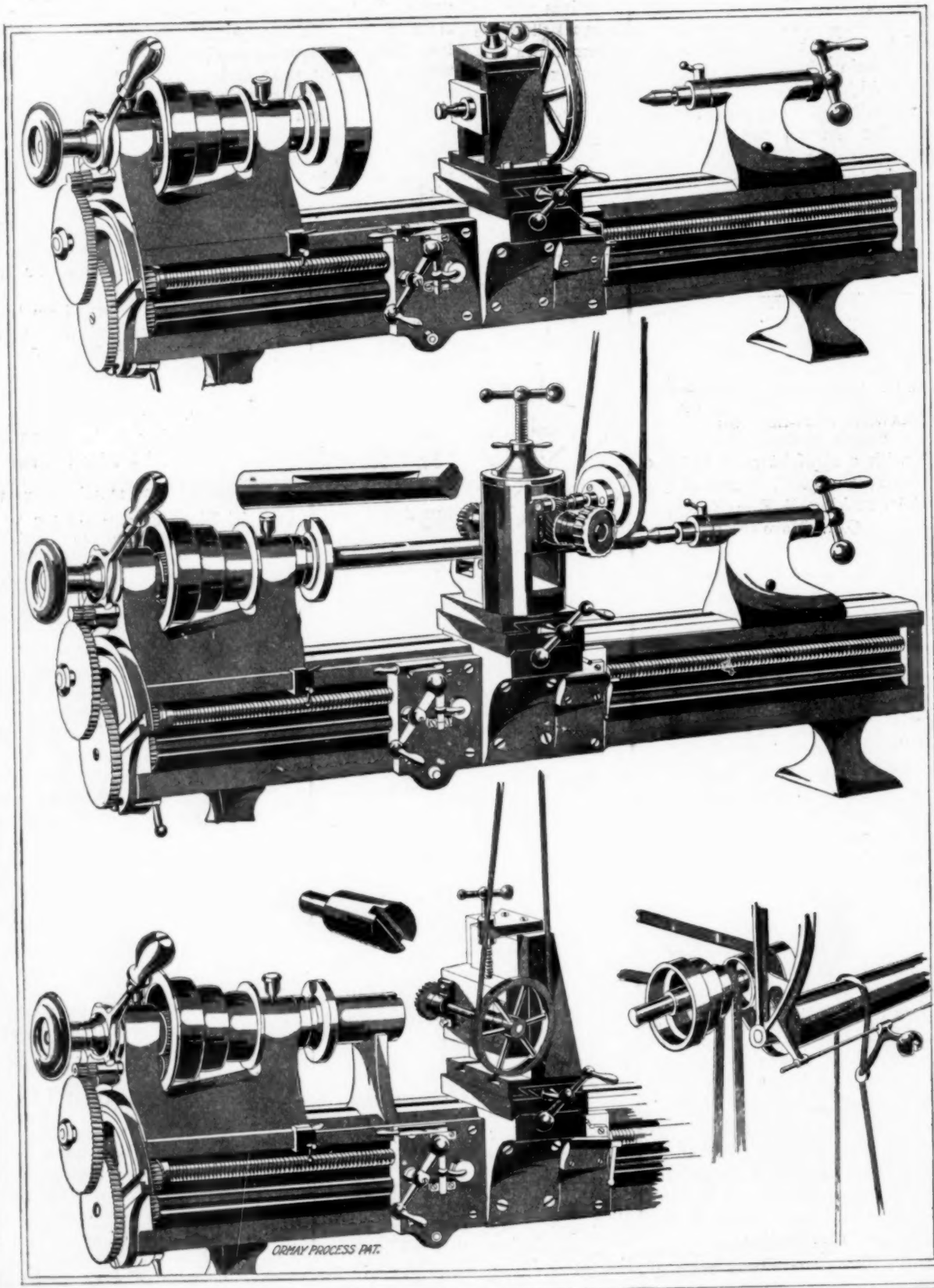
A Use for Broken and Worn-Out Drills

By John H. Blackman

In our shop we have for some time been using worn-out drills for end milling cutters as suggested by Oscar Craft on page 414 of *American Machinist*. We grind them straight across the end like a bottoming drill and then grind a small notch in the end of one lip so that the other is as long as half the diameter. They work much better ground this way and they can be fed straight into the work like a drill.

FOR SMALL SHOPS *and* ALL SHOPS

By J. A. Lucas



AUTOMOTIVE CONSTRUCTION

Special Parts for FOUR-WHEEL DRIVE TRUCKS

By
Harry C. Satterthwaite,
CHIEF TOOL DESIGNER, PREMIER MOTOR CO.

The pieces shown present problems which might easily prove puzzling, and the methods illustrated are full of suggestions for fixtures and tools for handling difficult problems in other lines of work. The pieces are rigid in construction and substantial grades are provided for maintaining the alignment of hollow milling cutters and other tools.

EVER since automobiles have been used, attempts have been made to apply the power to the front wheels. Moving a loaded vehicle by applying power to the rear somewhat resembles moving a load with a rope or fishing pole—it can be pulled much more effectively than it can be pushed. Applying power to the front wheels and steering with the rear is "going ahead backward," for you must run into a curb or other obstacle in order to run away from it. Steering and drive both in front have never successfully appealed to the passenger-automobile buyer, but have proved very successful when used on four-wheel-drive trucks. The war proved the value of the "quad." One of the best-known trucks of this type uses a shaft drive on both front and rear axles similar to the usual passenger-car rear axle. The steering is through a ball-and-socket joint on each end of the front axle, the drive shaft operating through a universal joint the center of which is in line with the center of the ball-and-socket joint. The headpiece illustrated shows one of these trucks equipped with ammunition body and camouflaged ready to "carry the message to Fritz." Fig. 1 shows one side of a front axle with the wheel in place and the ball-and-socket joint *A*, assembled complete.

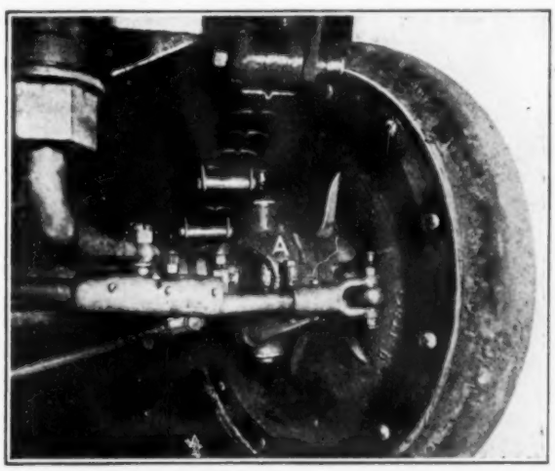


FIG. 1. FRONT-AXLE DRIVE STEERING JOINT

The sequence of operations on these balls as made by the Premier Motor Corporation, Indianapolis, Ind., which built several thousand of these trucks follows:

Anneal.
Snag.
Center both ends.
Rough-turn and face shank and flange; rough-turn neck.
Mill clearance notches in flange.
Drill through and rough concave.
Rough-turn outside diameter of ball.
Heat-treat; bore and ream and finish concave.
Finish-turn and face shank and flange.
Finish-form neck; bore and ream shank end.
Finish-turn outside diameter of ball.
Rough hollow-mill and face trunnions and turn collar.
Polish ball end.
Finish hollow-mill trunnions.
Drill oil holes in trunnions.
Drill bolt holes in flange.
Burr, complete.

The ball part of the joint is made from a drop-forging of 30-40 point carbon openhearth steel, heat-treated after rough machining and finished all over as shown in Fig. 2. The maximum tolerance is plus or minus 0.010 in., the minimum plus 0.0005 in. and minus 0.0000 inch.

A fixture, Fig. 3, with V-blocks *A* to take the trunions, a spring-actuated V-block *B* to equalize the ball sidewise and a centering jaw *C* for the shank, on the end of a clamp screw, hold a forging for centering. Center punches operating through bushed holes in the clamp screw *D* and the lower end of the fixture body accurately center the forging with respect to vital locating points so as to equally distribute the metal left for finish. The fixture is mounted over a notch in the bench so that the small center punch *E* shown on the bench by the fixture may be reached with a hammer. This lower punch is held in the fixture by means of a spring-wire retainer. The punches are made with loose heads fitted on a slight taper to be readily replaced when worn out. The average time on this operation is 2 minutes.

The centers are drilled and reamed with a combined drill and center reamer in a light drill press with a center on the table.

The shank and flange are rough-turned and faced and the neck between the flange and ball rough-formed, using the special turret head and tools shown in Fig. 4 fitted to a heavy-duty lathe. The illustration shows a forging on which this operation has been finished, placed in position for the first cut, which is made with three tools, one of which turns the flange diameter and the other two the shank. The right and left balls are slightly different on the shank ends, one of them having two diameters and a counterbore for shrinking over the axle tube. The other with the smaller shank is straight

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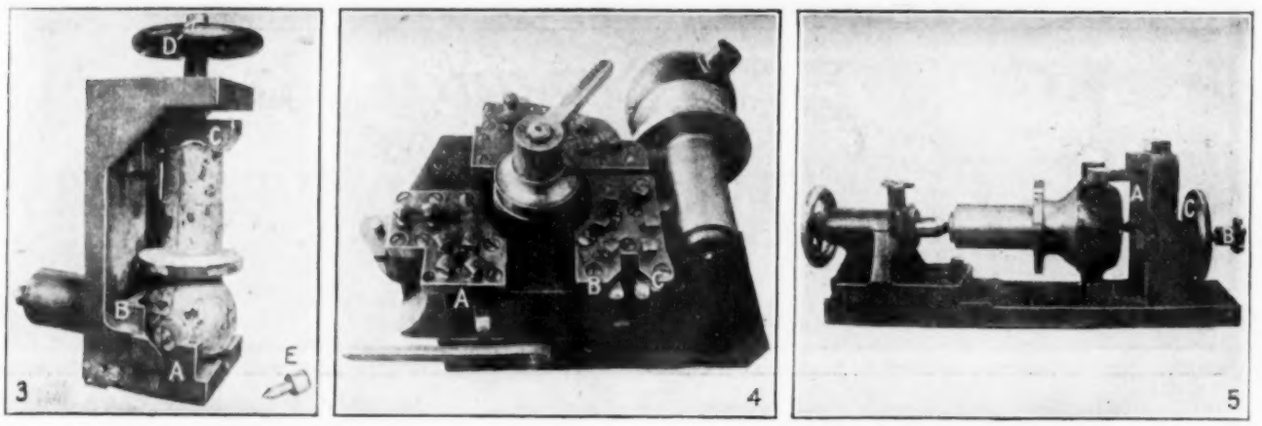

FIGS. 3 TO 5 PUNCHING AND MILLING FIXTURES AND TURRET HEAD FOR LATHE

Fig. 3—Center-punching fixture. Fig. 4—Special turret head for lathe. Fig. 5—Fixture for milling notches in flange

and has no counterbore, it being assembled into one side of the differential housing.

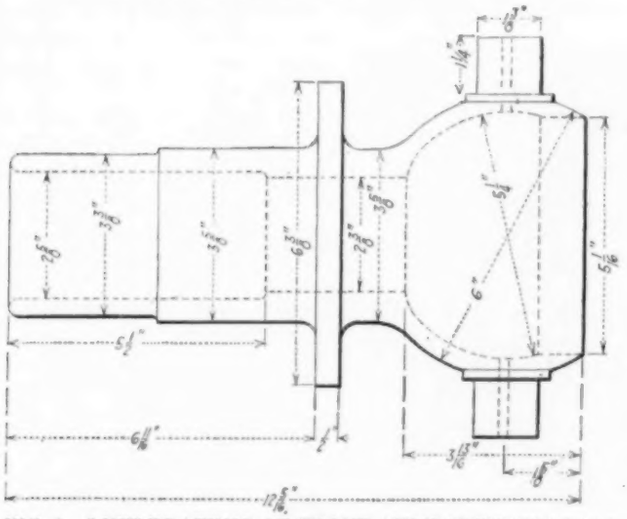

FIG. 2. LINE DRAWING OF FRONT-AXLE STEERING BALL

The tools *A*, *B* and *C* are for straddle-facing the flange and facing the end of the shank to length. The empty tool slot shown to the left is the position for facing the ball with the longer shank. The next face of the turret carries a serrated formed cutter for breaking through the scale on the neck and the fourth side a profile cutter for forming. Approximately $\frac{1}{16}$ in. of metal is left on each surface for finishing after heat treatment. The average time per piece is 23.3 minutes. Subsequent boring and turning operations are located from the shank and the adjoining face of the flange.

ROUGH-BORING AND CONCAVING

The notches are next milled through the flange, using the fixture shown in Fig. 5, which is equipped with an equalizing device *A*, operated by the star wheel *B* and locked by the handwheel *C*. The notches, which are clearance for the spring seat, are thus milled parallel with the center line through the trunnions and are used in later operations for driving the forging while held in various chucking fixtures. The average time for this milling is 6.5 minutes.

Fig. 6 illustrates the rough-boring and the concaving operations. These consist of drilling all the way through with a $2\frac{1}{4}$-in. drill and concaving $3\frac{5}{8}$ in. deep and $4\frac{5}{8}$ in. diameter with the double cutter bar shown. This is

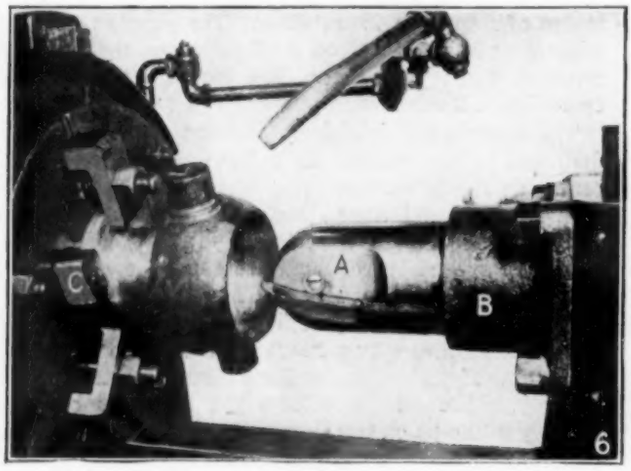

FIG. 6. ROUGH-BORE AND CONCAVE BALL END

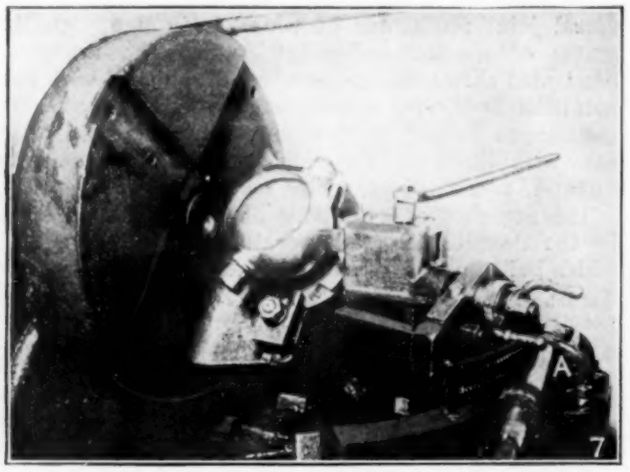

FIG. 7. FIXTURE FOR TURNING BALL SURFACE

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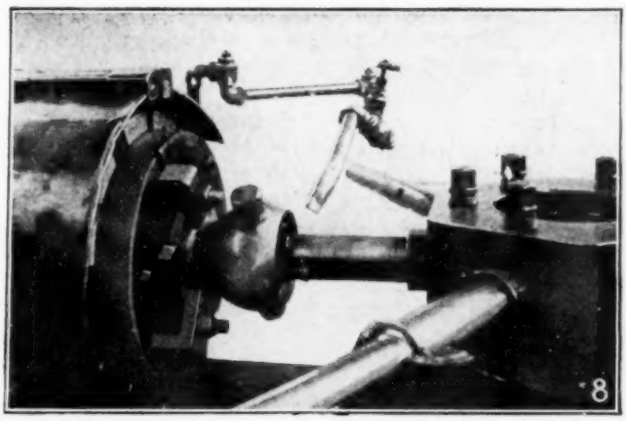


FIG. 8. FINISH-BORE AND CONCAVE BALL END

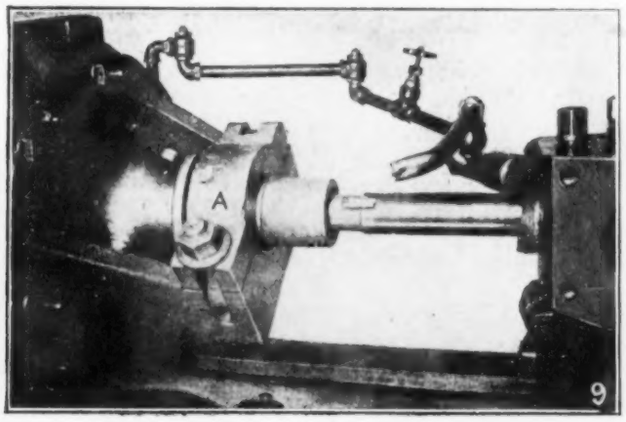


FIG. 9. COUNTERBORE FOR TUBE FIT

hardened-steel bar with high-speed-steel cutters set at an angle to give a good top rake. The cutters are held in position by small collars *A*, with one flat-tapered side, held down by fillister-head screws. The screw holes and the counterbores for the collars are drilled at a slight angle with the face of the cutter so as to give a wedging action against the flat side of the collar. The pressure of the cut forces the cutter to a seat, so the collars have very little duty to perform. The shank of this tool is keyed to a flanged turret adaptor *B*, which is bolted to the face of the turret. This prevents turning of the bar with consequent damage to the shank or breaking out the top of the turret as is possible if the clamp screw only were used. The chucking fixture holds the forging in a bushing for the shank, the flange being clamped against the face of the fixture which has a hardened ring fitted into the surface. One of the notches milled in the previous operation serves as a driver against a fitted stud *C* in the fixture. The average time for this entire operation on the Libby 16-in. turret lathe is 28.2 min., which include chucking, changing tools, etc.

In rough-turning the ball the forging is chucked in an angle fixture screwed on the spindle of a 25-in. LeBlond lathe as shown in Fig. 7. A radius-turning fixture doweled to the bed of the lathe replaces the carriage and swings a forged turning tool through the proper arc. This fixture is moved by means of a worm and gear shown at *A*. The depth of cut and consequently the diameter of the ball are regulated by a feed screw with a double-end handle. The tool carrier is gibbed to the swinging part of the radius fixture with V-ways similar to a lathe cross-slide and can be locked in position by means of the screw projecting through the top.

After the first cut is taken the lathe is stopped and the ball shifted to another position, six cuts being required to cover the entire surface. It could be done in four cuts if it were not for a slight interference of the flange and the radius to the neck of the ball. The average time for this operation, including chucking and changing positions, is 14.3 minutes per ball.

All surfaces of the ball except the trunnions have been rough-machined and the forging is next heat-treated. It is then placed in the same fixture as was used for rough-concaving, Fig. 8, and finish-bored, reamed and concaved. The tools shown in the turret finish the bores and bottom of concave up to the $5\frac{1}{16}$ in. diameter. The remainder of the concave is finished by means of a formed cutter held in the cross-slide tool turret, the carriage and cross-slide being operated by hand in order to match up the two cuts on the

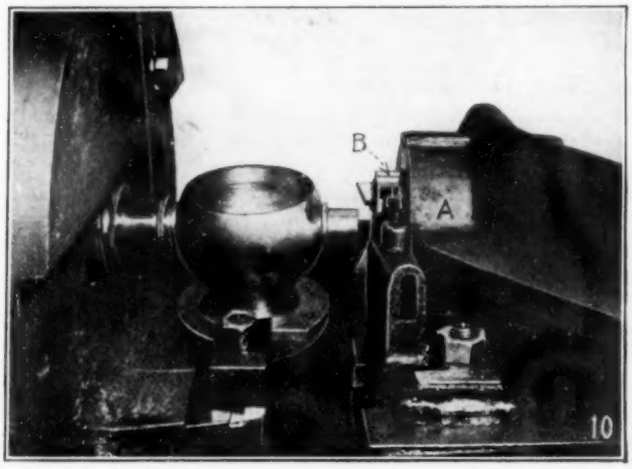


FIG. 10. ROUGH HOLLOW-MILL TRUNNIONS

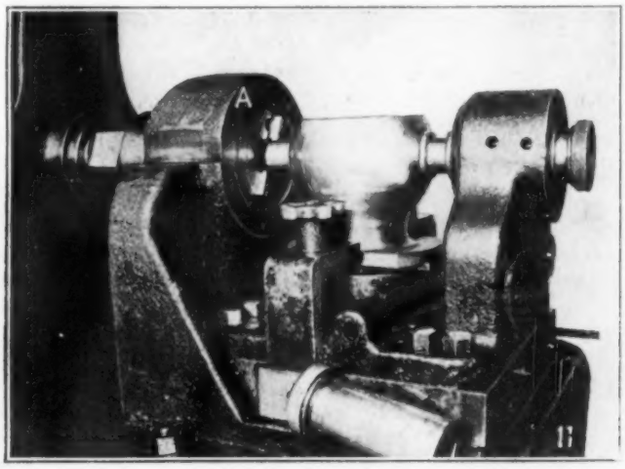


FIG. 11. FINISH HOLLOW-MILL TRUNNIONS

AUTOMOTIVE CONSTRUCTION

concave surface. The average time per piece is 28.7 minutes.

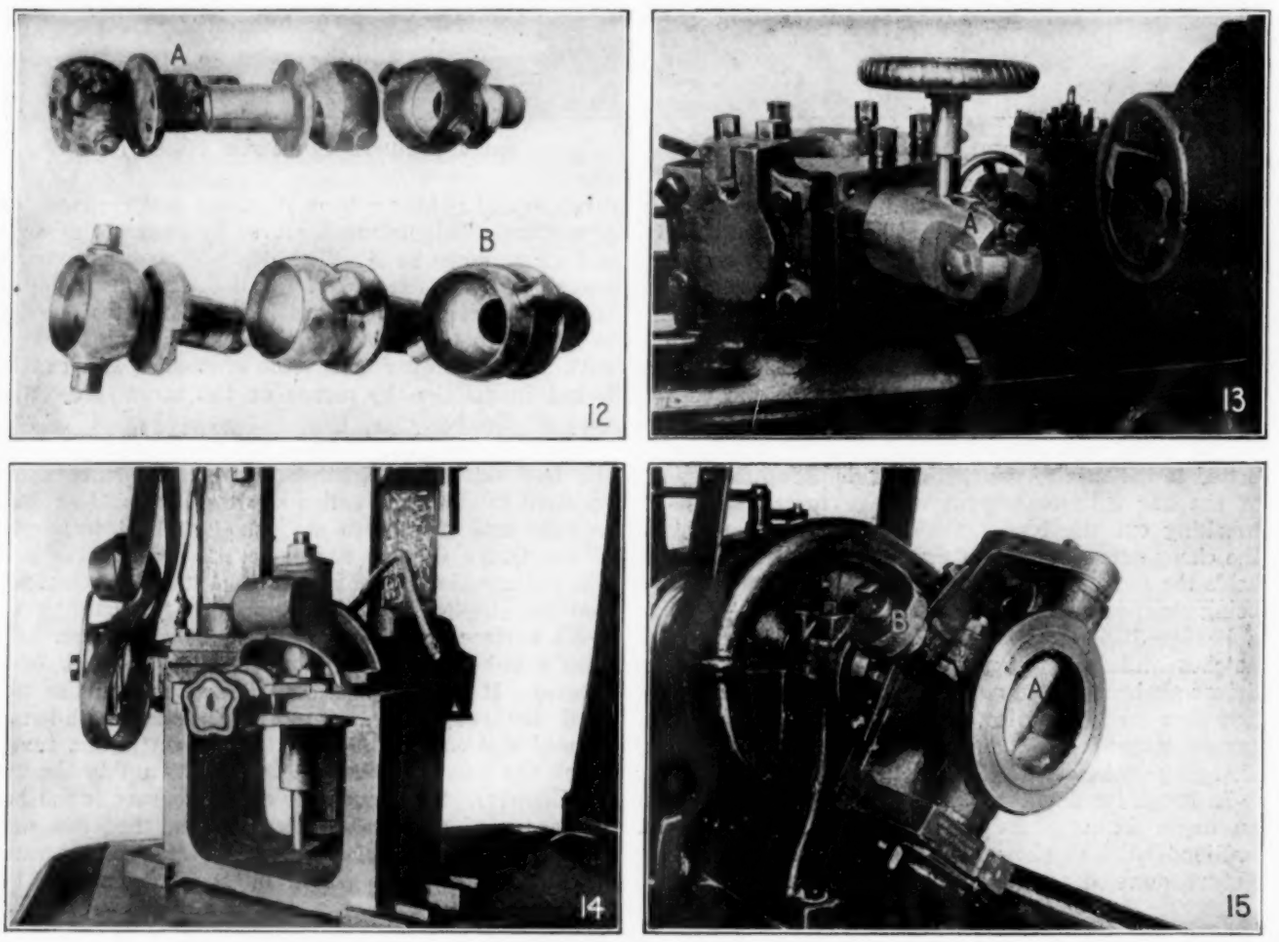
Both ends of the bore are chamfered in this operation so that the forging can be handled on pipe centers to finish turn and face the shank and flange and to finish-form the neck in the next two operations. The tools used are simple tool blocks, replacing the standard toolpost, using standard tool bits for one operation and a formed cutter similar to the rough-turning cutter for finishing the neck. The time on the finish turn and face operation is 15 minutes, and on finish-forming the neck 10 minutes.

The right-hand ball, which is counterbored on the shank end, is chucked in the fixture shown in Fig. 9. It is clamped on the finished shank in hardened half-bushings *A*, located from the ball side of the flange and driven by one of the notches in the flange. The cap is hinged to a link so as to avoid any distortion or eccentric location as is often the case with a single pin hinge. The average time per piece is 14.9 minutes.

The outside diameter of the ball is next finish-turned, using the same tools as for roughing, Fig. 7, except for the bushing bore in the chucking fixture, which must now handle a finished shank. No trouble is experienced in holding the ball within 0.002 to 0.004 in. of a perfect sphere, although the tolerance is much greater. The time on this operation is the same as in the rough-turning, 14.3 minutes.

In mounting this fixture on the lathe bed great care was taken to see that the center of revolution of the radius-turning fixture was directly in line with the center of the chucking fixture. A special arbor was ground up to fit the bore of the stationary part of the turning fixture and also the bore of the chucking fixture where the ball shank was held. The arbor was inserted in both bores, thus bringing them in line with each other and the fixture doweled to the ways of the lathe.

The balls are next clamped in a fixture similar to the one used for turning the balls, but with a sliding V-block to locate the first trunnion, which is roughed out with a hollow mill held in the tailstock of a 25-in. lathe. The carriage of the lathe is equipped with a bridge support *A* for the hollow mill *B*, Fig. 10. This support preserves the alignment of the mill and is splined to prevent the mill from turning. The tailstock is attached to the carriage so that the power feed of the lathe may be used, the tail spindle being used only for adjustment of the mill with respect to the car-



FIGS. 12 TO 15. THE BALL AND THREE FIXTURES FOR MACHINING IT

Fig. 12—Balls in various stages of completion. Fig. 13—Bore and concave socket member half. Fig. 14—Drill tie-bolt holes in socket member half. Fig. 15—Facing socket-member assembly

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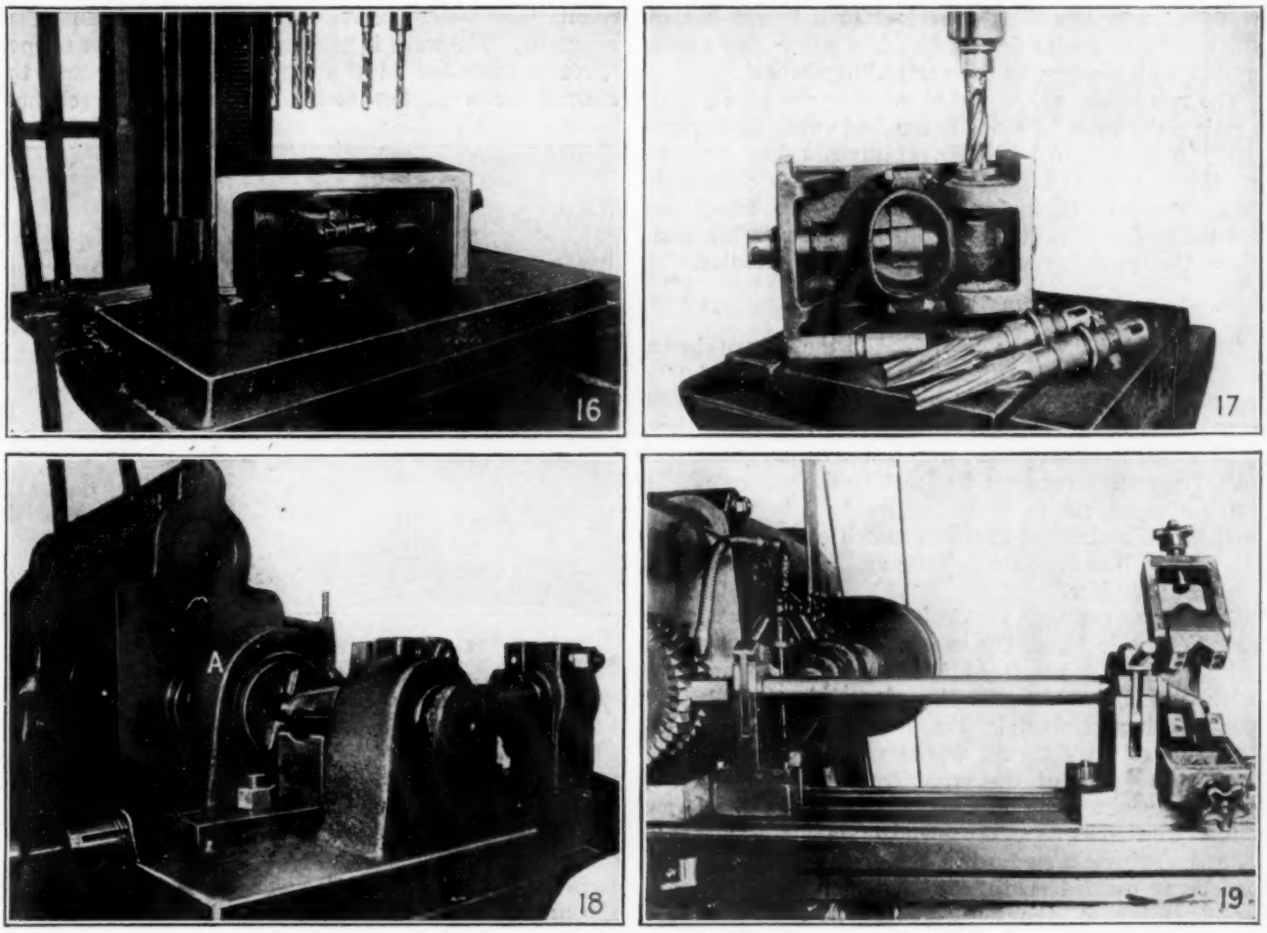
riage. The bridge is so constructed as to leave the cross-slide free, which carries a special tool block for facing the ends of the trunnions to length.

The mill is a Brown & Sharpe finishing mill without backrests, using two formed cutters diametrically opposite each other. These cutters rough-turn the trunnion and finish-turn the collar and fillets at the base of the trunnion. After one trunnion is turned the ball is revolved in the chucking fixture and a bushing slipped out of the center of the fixture over the trunnion just rough-turned trunnion. After the first trunnion is finished the clamps and bushings are removed and the work revolved to bring the other trunnion to cutting position. The slip bushing is changed for one with a bore fitting the finished trunnion. This bore has a very slight taper, just enough to take care of the 0.0005-in. limit. This bushing locates the trunnion first finished directly in line with the center of the hollow mill and the shank of the forging. The hollow mill is supported by a bushing in the fixture. The average time



FIGS. 16 TO 19. SPECIAL DRILLING AND MILLING FIXTURES

Fig. 16—Drill 12 holes in face of socket assembly. Fig. 17—Ream taper hole for steering arm. Fig. 18—Hollow-mill axle-shaft trunnions. Fig. 19—Mill axle-shaft squares

turned. The opposite trunnion is then roughed on a center line with the first one. The average time on this complete operation is 18.5 minutes.

The ball end is next polished to remove the tool marks, as experience has shown that on all balls broken in service the fracture originated at a tool mark.

The diameter of the trunnion, on which the tolerance is plus 0.0005 in. and minus 0.0000 in., is finished by a hollow mill with two cutters placed diametrically opposite similar to the mill used for roughing and supported as at *A*, Fig. 11. The mill is fitted to the spindle of a No. 3 horizontal milling machine and the work is clamped in the fixture shown. The first cut is located by a slip bushing, the bore of which fits the for finishing both trunnions in this operation is 7.5 minutes.

The $\frac{3}{16}$-in. oil holes through the trunnions are next drilled on a single-spindle drilling machine and the six bolt holes in the flange are drilled on a multiple-spindle drilling machine, locating the jig from one of the trunnions. This finishes the machining, the work is now ready for bench burring and final inspection.

Fig. 12 shows six of these balls in various stages of completion from the rough forging *A* to the finished ball, *B*. The rough forging weighs 65 to 70 lb. and the finished piece 22 lb.

The socket part of the joint consists of two members made from electric-furnace steel castings. They pre-

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sent several difficult machining operations on account of the close limits and the irregular shape of the castings, which make them difficult to hold without distortion. In the first operation the parts are held in a chucking fixture mounted over a three-jaw universal chuck on a 16-in. Libby lathe. The chuck jaws grip the shank and the ears for the tie bolts are held against two positive stops by setscrews. This prevents the casting springing when the intermittent cut is being taken on the concave surface. This surface is finished by means of a single-point cutting tool *A*, Fig. 3, mounted in a disk which revolves in a turret holder. The outside diameter of this disk is a worm gear which meshes with a worm on the vertical handwheel.

The two halves of the socket member are joined with a male and female fit which is roughed out in this operation. A facing tool held in a turret holder squares out the fit after it is roughed by means of a cross-slide tool. The hole through the shank is also bored and reamed to 0.002 in. less than finished size. This completes the operation which is done in 14.1 minutes.

Drilling Tie-Bolt Holes

The tie-bolt holes are next drilled in the fixture shown in Fig. 14. This fixture consists of two parts, a bushing plate and a holding fixture. The bushing plate has a male fit on one side and a female on the other, thus drilling either half of the member with the same bushings. The equalizing arms for locating the work straddle the bushing plate to locate either half being drilled so that the unfinished surfaces match each other when assembled. The time for drilling and reaming averages 4.8 min. per piece.

The halves are then chucked in a turret lathe on the male or female fit, as the case may be, with the shank end out. This end is faced, the bushing hole reamed to finish size, bored for the thread and tapped for the plug which assembles in the shank of each member. These plugs with thrust washers under them adjust against the ends of the trunnions on the axle balls, the load of the front axle being carried on the lower plug. The concave-socket member is slightly larger than the spherical surface of the axle ball, the bearing load being carried on the ball trunnions, the ball-and-socket feature of the joint serving as a housing for the universal joint in the drive shaft.

In the next operation the male and female joints are finished to gage on an engine lathe, the work being held on an arbor pressed in the reamed hole. This brings the faces true with the bushing hole after the hole is reamed to size.

The two halves are then assembled and afterward chucked in the fixture shown in Fig. 15. The assembled socket member is placed in the fixture and a special arbor *A* slipped through the bushings in the fixture and the reamed holes in the socket member. A knurled-headed screw *B* through the body of the fixture and at right angles to the arbor has two tapered surfaces which raise locating pins against the back surface of the socket assembly. This equalizes the stock so that the finished face will be parallel to the back side of the castings and at the required angle with the reamed hole through which arbor is placed. A fore-and-aft tool block replaces the cross-slide and carries two tools in both the front and back sides. These tools are set to rough and finish both the joint face and the male pilot. This male pilot fits a counterbore in the front wheel spindle, the 12 holes drilled in the socket member in the next operation being tapped to attach this spindle. This facing operation requires an average of 13.2 minutes.

The drilling of these holes is shown in Fig. 16. A channel-shaped jig carries the bushing in the web of the channel. The inside surface of this web has a counterbore which receives the male pilot of the socket assembly. The work is held in place by an arbor slipped through bushings in the flanges of the jig and the reamed holes of the socket assembly. The channel

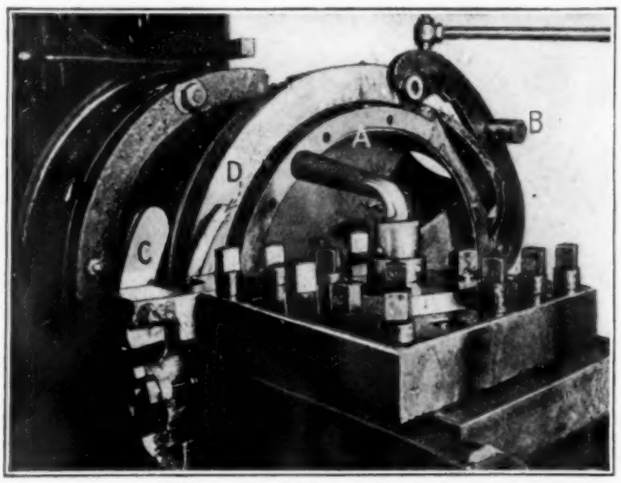

FIG. 20. HALF OF DIFFERENTIAL HOUSING WITH PINION BEARING

flanges serve as legs on which the jig stands while drilling. Two passes of the drills were used on this operation, drilling six holes at once. The average time per assembly is 8 minutes.

The boss for the steering-arm hole is straddle-milled and the taper hole is then drilled and reamed, using the tools shown in Fig. 17. The work is held with an arbor through the reamed bushing holes similar to previous jigs. The jig is made to be used either side up so as to make either right- or left-hand sockets. A three-flute drill is first run through the cored hole in the castings, being guided by a slip bushing. The taper is then roughed with a three-flute spiral reamer with notched teeth to break the chips. The hole is finished to gage with a 10-flute spiral reamer. The two reamers with Wizard chuck sleeves attached are shown in the front of the figure. The average time for this operation is 10.7 minutes.

Broaching the keyway in the taper hole, tapping the 12 holes and burring complete the operation.

As mentioned before the drive to the front wheels is through universal joints, the centers of which coincide with the centers of the ball-and-socket joint. The concave of the axle ball is for clearance over these universal joints. The shafts coupled to these joints are chrome-vanadium drop-forgings with trunnions forged

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integral on one end, the opposite ends being squared for fitting into the differential or the wheel-driving dog.

The axle-shaft trunnions have limits of plus 0.001 in. and minus 0.000 in. and must be concentric with the shaft bearing adjacent to the trunnions within 0.0005 in. The shafts are rough-turned on a Lo-swing lathe, heat-treated, finished-turned, shouldered and undercut between bearings on an engine lathe. The two bearing diameters at each end of the shaft are then ground and the ends of the trunnions straddle-milled with relation to the ground bearings.

The shafts are next placed in the fixture shown in Fig. 18. They are gripped on the ground bearing diameters by hinged clamps carrying a hardened half-bushing which hold the work into the other halves of the hardened bushings fitted into the body of the fixture. These clamps are opened on a vertical line so as to bring the shaft center always the same height whether the bearings are ground the high or the low limit. A slide, with a quick-action screw, locates the work for the first cut so that the trunnions will be central with the unfinished head of the shaft. After the first trunnion is machined the clamps are loosened and the shaft revolved one-half turn until the finished trunnion can be located by a slip bushing through the fixture. This slip bushing is directly opposite the hollow-mill support and in line with the center of the clamps which hold the shaft.

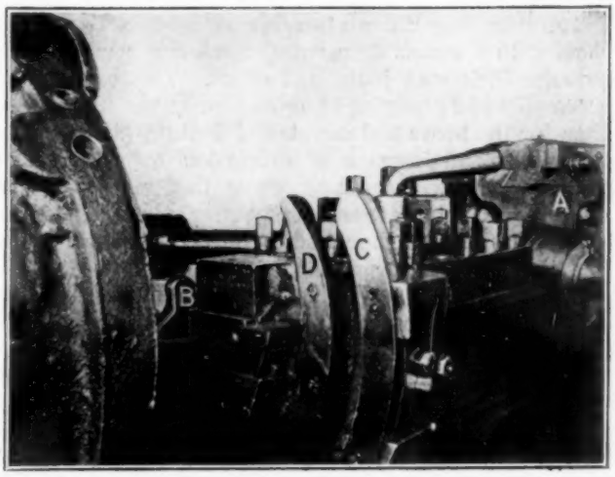


FIG. 21. CAM-OPERATED TOOL FOR FACING JOINT FACE

The hollow mill is a Brown & Sharpe finishing mill with two cutters placed diametrically opposite. A bronze sleeve pressed over the outside of the mill guides the mill in a hardened bushing in the fixture at *A*. The forging has about $\frac{3}{16}$ in. stock for finish on the diameter, this stock being both oblong and eccentric with the finish due to the flash and the wear of the dies. With these tools the trunnions are finished with one cut, the limit for the diameter being plus 0.001 in. and minus 0.000 in., and plus or minus 0.001 in. on the distance from shoulder to shoulder at the base of the trunnions. The average time per shaft is 8 minutes.

The next operation squares the opposite end of the shaft, using the fixture shown in Fig. 19. This shows a shaft which has just been squared and the trunnion clamp removed. One trunnion is shown in one of the locating V-blocks. The ground bearings which were used for holding the shafts in the previous operation are used for the same purpose in this, the clamps however, being split on a horizontal line. After straddle-milling two sides of the square the clamps are loosened, the shaft revolved so that the trunnion used for locating is seated in the other V-block and the clamp for this V-block tightened.

The V-blocks are placed so as to bring the center line of the trunnion 90 deg. apart in the two positions, when the trunnion is correct in size. As the tolerance is plus 0.001 in. and minus 0.000 in. the center line cannot be farther apart than 90 deg. nor closer together than 0.001 in. at the radius of the trunnion shoulder from the center. The fact that this radius is more than twice the radius of the corners of the square, the squares come out of the fixture with an error of less than 0.0005 in. at the corners. The two cuts, loading, etc., require 8.2 minutes.

As there are three different length shafts, both this fixture and the one for the previous operation (finishing the trunnion) are made adjustable, and the clamps which grip the squared end being movable to suit the three lengths of shafts.

Cam-Operated Facing Tool Designed

Fig. 20 is a view of one-half of a differential housing *A* chucked in a 24-in. Libby turret lathe. This housing carries the drive-pinion shaft and its bearings as well as the flange to which the torsion-arm collar is attached. This torsion-collar flange is $\frac{1}{2}$ in. closer to the center of the housing than the outside diameter of the joint flange. This shows a finished casting replaced in the fixture, the bolt holes more clearly showing the necessity for finishing all of the joint face and the back side of the torsion-collar flange where it overhangs the joint face. In order to finish all of this joint face a cam-operated facing tool was designed. Pin *B* contacts with cams *C* and *D* and moves the tool. This tool is shown from the working side in Fig. 21.

A stationary body is clamped in the cross-slide turret. The body carries a sliding member mounted on the conventional dovetail ways *A*. On this sliding member a toolholder is gibbed with another dovetail fit. This toolholder is adjustable in relation to the body of the sliding member by means of a feed screw operated by the star wheel *B* shown at the left, thus providing adjustment for wear of the cutter. The sliding member carries two profile cams *C* and *D*, which engage the roller mounter on the yoke shown near the pinion-shaft housing in Fig. 19.

The contour of the cams is such that the tool finishes the joint face with a flat cut across its width on a radial line. When the torsion-collar flange comes to the tool the cams withdraw the tool sufficiently to make it cut along the back side of the flange on a line tangent to the plane of the pinion shaft. When the opposite side of the flange is reached the cams return the tool to its extreme cutting diameter where it is held against movement from chatter by means of a spring.

On account of its effect on the finish tangent face

the tool is in constant motion, first toward the center and then away from it, while passing the flange. The joint face is roughed out to the largest diameter permitted by the torsion-collar flange by means of a heavy inserted cutter tool. The remainder of the cut is finished from the rough casting by the cam-operated tool, which successfully makes an oiltight joint on these faces.

The ability of these tools to perform their duty with the maximum of accuracy in the minimum time is the result of two things, first, the use of plenty of metal in their construction, which in fixture work never costs as much as its omission; and second, accurate work in building the tools. This was obtained by a rigid inspection as the work progressed and, if necessary, corrections made before the error could cause trouble. The designs were carefully worked out and where decimal dimensions appeared on the drawing the tool inspector held the toolmakers to a 0.0002 in. plus or minus limit.

Our Duty as Employers

By J. J. Hartley

Are we as employers doing our share just at this time to reorganize our plants on a fair and square, man to man basis, or are some of us unable to break away from tradition and take advantage of the present enormous supply of unemployed, able-bodied, skilled and unskilled men, a large proportion of whom have families, and are of real necessity seeking diligently for employment? The great majority of workers in machine shops are intelligent, reasonable and honest, and should be dealt with on such a basis.

The company with which the writer is connected happened to be in need of the services of additional men during the past two months and even though the plant is located at a considerable distance from the manufacturing center of Chicago, the eligible applicants have without exaggeration numbered 75 or more for every opening we have had to offer. We have not found it necessary to remind applicants that the war is over, nor have we tried to hire them at pre-war rates. We have, on the other hand, offered and are now paying a liberal guaranteed hourly rate to all our production workers, telling them frankly when hiring them that in due course they would be given piece work on which our time allowance would permit the average man to make 50c. per hour or better. When it is explained that this arrangement applies to intelligent men of limited or no prior experience we feel that the offer is fair. This, we believe, is recognized by our men, and particularly by those who have thus far been given piece work. These men made good from the start and are in the great majority of cases averaging more than 50c. per hour. This is from 30 to 40 per cent. more than the same class of labor received in the years just preceding the wer.

The writer having personally interviewed the majority of the applicants since the middle of December, has reason to believe that some employment agents have been endeavoring to hire intelligent workers at a considerably lower hourly rate than the high cost of living would justify. The safest and fairest policy for the employer to pursue is to fix a schedule of wages and salaries that will insure the appreciation of the employee, since a fair deal will always be quickly recognized by the great majority of men employed in manufacturing industries.

The man with the important responsibilities of hiring help, to be successful, should receive an applicant in a cheerful and sympathetic manner. In fact is not the man who offers his skill and labor direct entitled at least to the same courtesy and consideration as the salesman, who also, but indirectly, offers you labor in the form of the finished product which he has to sell? It is not good business nor fair to the man who may, at great loss of time and some expense, come to our plant to offer his services, to be greeted with a shingle: "No help wanted." We owe him the courtesy of an interview and if we cannot employ him we can at least offer him an explanation why. There is a limited number of manufacturing concerns who are fortunate enough to have always recognized the hiring of and dealing with employees as of first importance. It is safe to say that the employment department records in such establishments will always show a profit resulting from the minimum help turnover which invariably prevails there.

The next big thing after hiring men is to provide them with a means of earning maximum compensation through their own individual effort. This can best be accomplished by paying them at a price per unit rather than for the hours and minutes of working time. Superintendents and foremen who have had experience with both systems will probably agree that most workmen will produce a larger output of better quality under the piece-work system than under the hourly rate method, and that once the workmen become accustomed to the greater possibilities in the way of returns from the former system they are very reluctant to return to the old one.

To be successful a piece-work system must be based on average performance and not on that of a picked expert and must take into account all the factors that may enter during a long working day. Careful analysis will divide the workers into five classes of which the middle one should be chosen as the basis of price per piece calculations of the minimum guaranteed rate and maximum possible earnings. Production records of many of the concerns operating on this basis show that the higher and lower classes usually balance each other so that the average earnings will be equal to those of the middle class man. When a man is started on piece work he should be told what the minimum returns to him will be for a fair amount of diligence and also that the price will not be reduced so long as conditions under which it was determined do not change appreciably. He should also be encouraged by being told that if he can make double the minimum rate by extra effort the company is glad to have him do it.

To Prevent Tracing Cloth From Stretching

By A. E. Kipps

I have used the simple kink as noted below for some time and have found it very handy. No doubt many readers know that when a tracing is left tacked to the drawing board for any length of time it stretches considerably. I overcome this difficulty in the following manner: Before leaving the tracing simply take out two thumb tacks from the opposite corners. The tracing may now be left as long as you please and will not stretch. It takes but a second to replace the tacks when commencing work on the tracing again.

Arrangement of Equipment in Shops

BY JAMES FORREST

The principles of scientific shop layout are here taken up and reduced to the form of equations for convenience in handling. Straight-line and contract-shop layout problems are contrasted and a solution by the aid of cardboard models is described.

THE problem of planning the location of the tools and equipment in the layout of a new shop lies between the extremes of simplicity and of a complexity of requirements which can only be approximately satisfied, depending on the business to be carried on. The first point to be considered is the matter of cost in transferring the product components coincident with plant operation over a definite number of months or years between certain predetermined dates.

In all plants there exists an expectancy of gradual increase in sales to be offset by a corresponding increase in output capacity. It will be necessary in making any layout to assume a set of requirements to cover a specific output, and if the layout is based on present requirements it will become inadequate in the course of time and its various components will no longer operate at their highest efficiency. On the other hand if the layout is made to cover requirements too far in the future everything will operate at reduced efficiency until production rises to the proper volume to fully utilize the available resources. The best that can be done is to select a reasonable output standard, making provision for expansion based on past growth and future plans without introducing inordinate crippling factors during present operation.

Every layout scheme must have an entering and a leaving end and these are set to the points of the compass which will give the unit under consideration, be it a complete plant or a small department, the most efficient relation to those outside influences directly affecting it. In some instances conditions will necessitate that receiving and shipping take place at the same end of the plant or the operations may be carried out along the first floor and return along the second, and this can also be done where space is to be saved.

Laying Out a New Plant

In most plants of any size having no regard for scientific layout it will be found that convenience has compelled at least an approximate segregation of the departments such as the forge shop, machine shop, foundry, stores, etc., while in a small shop it may be that only certain corners are devoted to certain pursuits. But in old-established shops this is about as far as the subdivision goes, and the engineer called in to lay out one of a group of shops on the basis of efficiency will be fortunate if he is not forced to compromise on some seemingly indispensable points on account of its established relations with the other shops.

In laying out a new plant more freedom is possible, practically the only limits being the relation of railroad sidings to the bringing in of raw materials and the supplies for converting it, and the shipping of the finished product.

As a preliminary to any layout it will be necessary to separate the products into their component items and these again into their operation items, information being arranged in tabular form for comparative purposes. This table will show the number of pieces of each kind passing through the shops every working day and also the total time for which each machine is occupied during an operation, so that the complete machine or equipment time may be found for every item composing the product.

The total number of units will be: Number of operations on each piece; storage; repair shop; millwright; toolroom; special department, such as foreign inspection; shipping.

The size of these units of manufacture will be determined by the quantities produced, as in many cases suitable operations for combination will be performed in the same shop.

Through each shop will pass a number of pieces equal to the output per working day, and the number of machines required of any type =

$$\frac{\textit{Output} \times \textit{operation time in hours}}{\textit{working hours per day} \times 0.9} \quad \ldots\ldots (1)$$

Area of shop required =

Clearance area of machine (including operating space) × No. of machines, plus storage and handling space, plus inspecting and erecting space..... (2)

Layouts for Straight-Line Products

The simplest layout is possible when the product is a so-called straight-line product which can start at so many pieces an hour at one end of a shop or series of shops and go from one operation to another as in the manufacture of a single-piece product. This seldom occurs, but the most complicated processes of manufacture when analyzed resolve themselves into a combination of these straight-line paths.

Then there is the plant the product of which is made in such large quantities that a separate department containing certain equipment can be established for each of the various parts making up the finished product. Examples of this kind are the artillery shell and the automobile. The product is divided into its components and these again designated as parts manufactured or parts bought. The shops manufacturing some of the minor parts and the stores containing the purchased ones are located in the proper sequence and join the principal part just when needed as tributaries feed a main stream. In this way economy in handling is at a maximum, interference at a minimum and overlapping and return of the product over its own path are done away with. In a layout such as this enough machines and equipment are grouped at each station or operation shop along the path to take care of a certain predetermined number of pieces passing through in a certain time.

Such conditions can in general only be realized in the

putting down of new shops built for the express purpose in hand, but much will be accomplished by bearing the above principles in mind in the accommodating of any preëxisting shops to a new product or in the readjustment of a shop and a product that have become unbalanced.

If the product is a new one and there is not enough data to enable the engineer intelligently to balance the individual operating equipment, space should be provided in each shop to take care of the possible need for additional equipment which may develop after manufacture is under way. On the other hand, there is also the possibility that all the machines installed will not be required. These unforeseen retardants of the production stream sometimes manifest themselves in an alarming fashion after operations have been started, and for this reason the individual output of each machine or other unit should be established with extreme caution before it is embodied in any general scheme. If there is any error it will be multiplied in proportion to the number of machines employed. I have seen in one plant alone shops full of machines which, after all the expense of installing and equipping them with individual motors, never once revolved because this output factor had not been carefully established before purchasing and installing, the necessary output being obtained by machines of another type doing the same work but with 10 times the capacity. Half a million dollars did not cover the cost of this one error.

Layouts for Repair and Contract Shops

In layouts of this kind to cover straight-line products and where enough machines are installed at each point to cover the exact requirements no handling factor calculations will be necessary, as the most efficient arrangement is apparent on the surface. But there are shops, like repair and contract shops, in which the product is made up of varied items on some of which certain machines perform all the work, while others perform very litle work, and where the various items pass under the machines in mixed rotation.

In these instances it will be necessary to use what has been done in the past as a measure for the future, and after the probable requirements in machines are determined from formula 1 the best that can be done is to divide the machinery for each shop into groups depending on the work performed, as follows: Very heavy, heavy, medium, light and very light. Then starting at the entering end of the shop layout place first the very heavy machines, next the heavy, and so on, finishing with the very light at the opposite end of the shop. Machines like planers, slotters and boring machines are placed on one side and lathes, milling machines or shaping machines on the other, with the drilling machines, saws, etc., wherever convenient.

Next are those shops where large enough quantities of any one item to keep a unit of equipment busy cannot be put through, as where the product varies with local requirements of the customers, such as cranes, boilers or locomotives. In these cases it is impossible to hold the essential facts in mind at once and layouts must be made and tested by the handling factor.

In many cases the shops will be built before the equipment has been fully decided upon, and the problem will resolve itself into making the best utilization of space already provided. A plan of the shop or department in question is made to scale on the drawing board, about $\frac{3}{4}$ in. or $\frac{1}{2}$ in. = 1 ft. being suitable and showing all features in any way liable to affect the machine layout. Then for each machine an approximate shape to clearance dimensions is cut out in cardboard to the same scale as the shop layout, showing the position of the drive, the position of the operator and the extreme travel of the various working parts. At the same time cardboard cutouts are made for transfer trucks, bins, work benches, etc.

The Ideal Layout from a Handling Point of View

As all the machines cannot be placed to give straight-line motion to all the items it will be necessary to make the most efficient approximation to this. The ideal layout from a handling point of view for shops with short-run products would be to have each piece given a group of machines to itself no matter how little some of them were used in a day. But as this is not feasible from a cost standpoint the best combination must be made so that each machine is occupied all the time, the handling factor still remaining low.

A group of machines is taken from the cardboard supply to cover the total requirements for each piece as given by formula 1, taking a whole machine for each fractional machine required by the formula, as three lathes where a piece takes the equivalent time of 2½ lathes per day by the formula, or one planing machine where 0.3 is required. On the cardboard machine that represents the fractional machine requirement this fraction is plainly marked, and for reference the same fractional part of its surface may be colored with a crayon.

A layout of all these cardboard machines to finish each piece is made on separate sheets from the shop layout, the machines being set out to scale with proper clearances for moving trucks and standard work racks in the relative positions they would occupy if each group stood alone. This is done for every piece appearing on the tabulated sheet of output operations which has already been made out as previously indicated, and when all these small layouts are made we have before us a number of groups of machines in which each group covers the work to be done on one piece or item of product. We have now to combine to the best advantage the fractional machines to make up even whole numbers so that all may be busy all the time.

The group sheet representing the heaviest piece is superimposed on the shop layout nearest to the entering end; then another group sheet is selected the fractional machine requirements of which fit in best with the first one, trying if possible to find one that will eliminate all the fractional machines. This process is gone through until all the group layouts have been used up, keeping as much as possible the heaviest parts at the entering end of the shop on both sides of the central open space. Those fractional machines nearest to each other of the same size and kind which add up to one complete machine are now removed and a whole machine laid down central to them to take their place. Slight readjustment will now close up the few gaps made by fractional machines removed and the small sheets can be taken away, one by one, pinning their machines down on the shop layout in the same places

they occupied on the small sheets. We now have the complete shop layout made, with every machine fully occupied during the working hours per day.

Each item should now be tested by the handling factor which is equal to the weight of the piece multiplied by the distance it is moved between each operation multiplied by the number of these pieces moved per day.

When the handling factor is high for one piece through its having to be moved back on its path for the purpose of utilizing a machine which otherwise would be idle, judgment must be used as to whether it will be more profitable to allow the high factor or to install another machine to perform the necessary work on the piece at the proper point on its path. For instance, it would be more economical to provide an extra drilling machine to eliminate the necessity for the return of 20 heavy pieces per day a distance of 50 ft. for a drilling operation, while it would not pay to install another large planing machine under the same conditions.

A layout in any plant will have its own peculiar conditions to be met, depending on the class of equipment to be installed, but the above indicates the procedure that will get to the required result in the shortest time.

The Use of Defective Articles

By Chesla C. Sherlock

The practice of using defective machinery without affording the manufacturer an opportunity to make good on his warranty and then trying to collect damages from him for losses due to the defects is unfortunately entirely too common. It savors of the good old army habit of "passing the buck." A knowledge of the attitude likely to be assumed by the courts would probably have saved much time and money by stopping such actions before they started.

VERY often, when manufacturers engaged in making machinery or appliances sell their product, it develops that certain machines or appliances sold are defective in workmanship or material, a possibility which is recognized by provisions in the contracts of sale which define the duties devolving upon the purchaser. It is not proposed to discuss the manufacturer's liability from the standpoint of the sale of such defective product, but rather to discuss it from the standpoint of the use of the product by the purchaser who knows that it is defective.

If a purchaser of a machine which turns out to be defective continues to use the same, such action on his part may cause serious damage to the manufacturer in any one of a number of ways. It may ruin the machine to operate it in its defective condition and thereby entail a greater loss upon the manufacturer; it may cause accidents to the purchaser's employees, the liability for which the purchaser may attempt to shoulder on the manufacturer or it may bring the manufacturer in conflict with certain state statutes relating to the machinery which he has installed, but which, for some friction of law, is often deemed to be his own property. In cases where a machine suddenly breaks down during the trial period when it is not known that it is defective, the liability of the manufacturer is generally well known. He may, in some instances, even be held liable to third parties for the negligent construction which caused the accident or injury.

When the manufacturer expressly agreed with a purchaser that in case the machine is defective he shall immediately give notice to that effect and refrain from the use of the machine for a reasonable time until the manufacturer can repair it, or substitute a new one, the persistent use of it by the purchaser is something over which the manufacturer has no control and should not be expected to bear. This is the general rule of law applicable in such cases. Sutherland, a recognized authority on the subject of damages, says: "Where property is sold with a warranty of fitness for a particular purpose, if it be of such a nature that its defects can be readily and, in fact are, ascertained, yet the purchaser persists in using it, whereby losses and expenses are incurred, they come of his own wrong, and he cannot recover damages for them as consequence of the breach of warranty."

The manufacturer's liability to the purchaser in such cases is generally predicated upon his warranty of good workmanship or material and that the machine is a good machine for the purpose for which it is intended. But the courts have said that the warranty is not confined solely to the manufacturer. He is only a party to it and he cannot be held to answer in damages for the consequences unless the agreement entered into at the time the warranty was given is fully carried out by the purchaser.

The provision as to what the purchaser shall do will be found to vary in different cases but the manufacturer generally specifies in his printed form for the contract of sale, that the purchaser shall give notice to him immediately and that if the defective machine is not repaired within ten days or some such period, the contract shall be considered void. Unless the purchaser performs his portion of the agreement by giving notice and waiting the reasonable time during which he does not operate the machine, he cannot come into court and attempt to hold the manufacturer to his warranty when he has not, in his own case, held himself blameless. "He who comes into court must come with clean hands."

An Iowa Court Decision

Such a decision was reached in an Iowa case when it was shown that the purchaser of a machine warranted free from defects used it with full knowledge that it was defective and in an extremely dangerous condition so that the operator was injured. The court said that the purchaser could not hold the seller of such a machine answerable for damages which were occasioned by his own negligence in using the machine.

In a Kansas case, an engine was sold subject to a warranty in which it was stated that the machine was manufactured of good material, of good workmanship, and, by proper management, would perform well provided the rules and directions furnished by the manufac-

turer were carefully followed. In case the machine proved defective written notice was to be given by the purchaser within ten days of its installation and a reasonable time allowed for the sellers to remedy the defect. In case the manufacturer found any defects, they were to be remedied; if the trouble was in the engine, it was to be taken back by the manufacturer and all payments made refunded. It was shown that the purchaser operated the engine for three years and then claimed damages of the manufacturer, alleging that the engine was of poor material and workmanship, and that it was unfit for the purpose intended. The court said: "Where a machine is purchased which does not meet the conditions of the contract and the defect is one that can be remedied or easily repaired, it is the duty of the injured party to take reasonable steps to have the defect repaired, and to make the liability of the other as light as possible. Damages cannot be awarded on the assumption that the defect is to continue indefinitely."

Can Purchaser Claim Damages

Very often the continued operation of a machine in a defective condition will give rise to other defects, in no way chargeable to the manufacturer, and which are directly due to the fact that the machine was operated for some time while in its original defective condition. Any competent machinist knows that it is true that the greatest injury in the operation of a defective machine is often due to the machine itself. Can the purchaser then come into court and claim damages for such additional defect? In a Kentucky case, this very proposition arose and the court held that no damages could be recovered which were due to the wrongful operation of the machine.

This matter should be reasonably apparent to all who are competent in the operation of machines and appliances. There is nothing strained or far-fetched about it, yet purchasers are continually attempting to overcome it in the courts and secure damages from the seller for things which are not his fault and which are entirely beyond his control. It is certainly just to say that no man should profit by his own wrong, but why it is attempted so often in cases involving defective machinery is a riddle which has never been solved.

A New York Case

In New York, it was shown that a party had purchased steel warranted to be first class from which, he told the seller at the time, he intended to make oil drills. Although it was found that the steel was defective and unsuitable for this purpose the purchaser continued to make it up into oil drills in spite of his knowledge of this fact. He then came into court and attempted to recover the expenses incurred or the loss of profit, but the court said that as soon as the purchaser discovered that the steel was defective he had no right to continue using it with the expectation of recovering his loss of profits from the seller. The court further said that if the vendor sells property and warrants it to be suitable for a specific purpose, and it is applied to that use and proves to be unfit, he is liable in difference in value between the article as it really is and what its value would be if as represented.

The New York case points out a very good distinction to bear in mind in instances of this kind. The court said that the warranty must apply to the particular use to which the property is to be put and that a general statement on the part of the purchaser as to what he intends to do with the property is not a sufficient agreement or linking up for the general warranty made to invoke the application of the rule announced herein.

This is a very good point to bear in mind in regard to all warranties. In order to sustain them in court and make recovery for their breach, it will generally be necessary to show that the warranty applied to the specific thing of which the purchaser claims there was a breach. If the purchaser goes to the seller and states that he wants a machine for a specific purpose and asks if the seller will warrant his machine to be a good one for that particular purpose and the seller so warrants his article, then there is a specific warranty as to the particular use. But if the purchaser casually states in the course of the sale that he thinks he will use the article for a specific purpose, there is nothing binding, especially in cases where the use intended for the article is out of the ordinary.

Making the Proposition Clearer

A homely illustration may make the proposition clearer. Suppose that a purchaser goes to a seller and wants to buy a horse. The seller makes a general warranty as to the fitness and soundness of the horse. The purchaser then states that he expects to use the horse on the race track. The general warranty made under the circumstances cannot be construed as saying that the horse is a good race horse. But if it can be shown that the horse was specifically warranted as a good race horse, very different considerations arise.

In the case of use, then, we find that where the purchaser has knowledge that the article is defective he must

1. Use every effort to lighten the liability of the seller under the warranty as much as possible.
2. Exert every reasonable effort to have the article repaired or caused to be repaired in order to perform this duty.
3. Fully perform his portion of the contract before calling upon the other party for damages.

Saving Machine Work in the Foundry

By Sandy Copeland

On page 555 of the *American Machinist*, M. E. Duggan says he saw a machinist doing a lot of work that could have been avoided by a slight change in the design of the casting, which would have made it possible to so mold it as to eliminate a large part of the machine work.

The casting was a door for a large furnace and the job was the drilling of 46 holes through which passed the anchor bolts to hold the firebrick lining. Mr. Duggan contended that if the holes had been cast in the door and the bolts cast into the anchor ribs, the whole could have been assembled with little machine work. So far so good, but his next alternative is a method of casting in the fire bricks themselves and eliminating *all* the machine work. In this case when it became necessary to replace the bricks all that would need to be done is to make a mold with new fire bricks in it, melt up the door and pour it around the bricks.

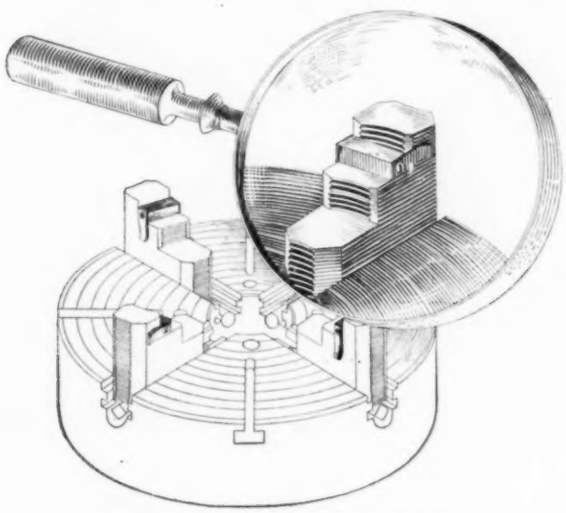
By the way, isn't 15 to 25 hours, with a few hours one way or another thrown in to cover errors is estimating, a good long time in which to drill 46 holes?

Handy Blocks for Chuck Jaws

By O. E. Charles

Many times in boring comparatively large holes in thin pieces it is desirable to block the work away from the chuck jaw in order to let the boring tool pass through without interference.

Instead of hunting up three pieces of scrap each time I have this kind of job and trying vainly to hold all



HANDY BLOCKS FOR CHUCK JAWS

three of them in position with one hand while I set the work with the other, I made two or three sets of the pieces shown in the sketch. These can be slipped on the chuck jaw and will stay in position, leaving the hands free to locate and clamp the work.

The pieces are equally serviceable for blocking a piece away from the chuck jaw or for blocking between the chuck jaw and the periphery of the work.

Instruments for Hardness Tests

By P. P. Fenaux

In his article on "Instruments for Hardness Tests" on page 93 of the *American Machinist*, Mr. Clewell mentions two modifications made in the Brinell testing machine in order to increase the speed of testing. During the war the French artillery constructors found themselves up against the same problem, and a French officer developed a portable Brinell tester that does not require a press or machinery of any description for its use. The instrument is based on the comparison between the diameter of the impression made in the specimen and the diameter of the impression made at the same time in a standardized sample of steel.

The Brinell hardness number D is defined as

$$D = \frac{P}{S}$$

where P is the pressure and S the surface of the spherical impression. If d is the diameter of this section and a the diameter of the ball

$$D = \frac{P}{\pi a\left(a - \sqrt{a^2 - d^2}\right)}$$

If the impressions on the specimen and the standard are made at the same time P is then a constant and the only variable is d. Therefore if D_1 and d_1 are respectively the hardness number and the diameter of

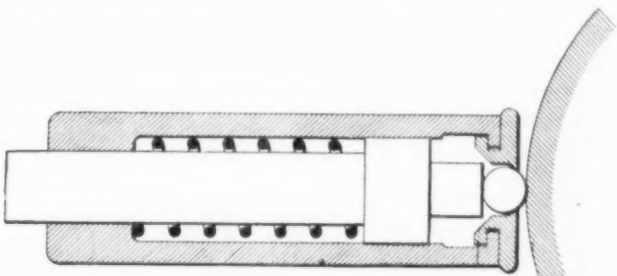


FIG. 1

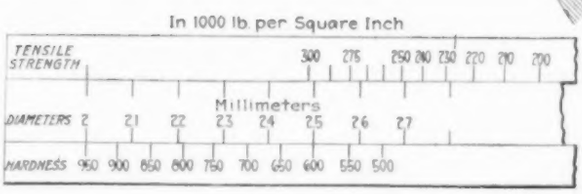


FIG. 2

FIGS. 1 AND 2. PARTS OF PORTABLE BRINELL TESTING KIT

the impression of the specimen, D_1 can be determined from D, d and d_1, where D and d are the corresponding values for the standard block.

The instrument is composed of an aluminum tube into which slides a hardened-steel plunger as shown in Fig. 1. A lower cap locked in place by half a turn retains the standardized cube and the 10-mm. ball which makes the impression. The whole thing is about four inches long.

Impressions are made by holding the instrument hard against the specimen, the spring insuring good contact between the specimen, the ball and the standard, and hitting a hard blow with a hammer on the head of the plunger.

With the aid of a small folding microscope included in the outfit the impressions are measured to within a few thousandths and a special slide rule gives the hardness number sought. The slide rule is graduated as indicated in Fig. 2. By setting the diameter of the impression on the standard above its hardness number on the lower scale either the hardness number of the specimen or its tensile strength can be found in line with the diameter of the impression.

For very accurate determinations it would be advisable to take into account the difference in hardness between faces with and across the grain, but this instrument is mostly a shop tool.

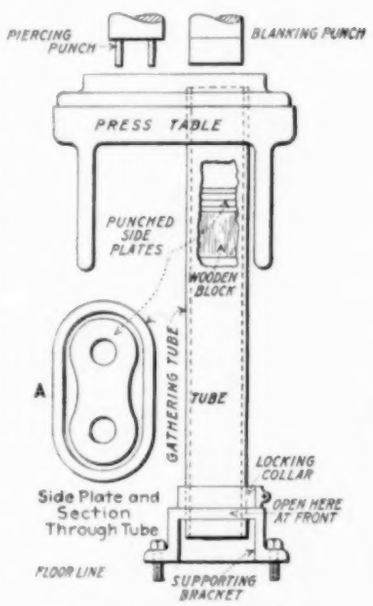
It is used by foremen for calculating from the hardness the cutting speeds allowable and by storeroom keepers for checking the carbon contents of unmarked bars of steel. It also allows of testing the hardness of parts too large to be handled under the standard Brinell tester and the result of their heat treatment.

Automatic Stacking of Chain Links

By M. E. Duggan

In an article on the manufacture of diamond transmission chain, page 1077, Vol. 49 of the *American Machinist*, J. V. Hunter says: "Some hand labor is used in gathering the parts and so arranging them that they may be properly placed in the machine magazine."

Here is a method for a similar operation in the manufacture of bicycle chains that may be of interest. The side links of the chains are pierced, blanked and gathered in a single operation on the punch press. A steel tube shaped as shown in the cut at *A* fits in a corresponding recess on the under side of the die and is held by a supporting bracket. This bracket has a split band which is adjusted tight enough to allow the tube to slip down and clear the die and press table in case of accident to the tools. A block of maple wood is shaped to fit tightly into the tube and is placed at the top end of the tube. As the side plates are punched this block recedes down the tube and at the same time the friction is sufficient to keep the blanks together and flat in the tube.



STACKER FOR BICYCLE CHAIN LINKS

When the tube is filled the operator is notified by means of an electrically connected bell. The full tube is removed and another tube, with follower set, is ready to be placed in the press.

The full tube is held in a vertical position, wires are dropped down through the holes in the links and the tube is then reversed and lifted vertically away from the links, leaving them laced on the wires ready to be transferred to the chain assembling machine, or the tumbling barrel to have the burs removed.

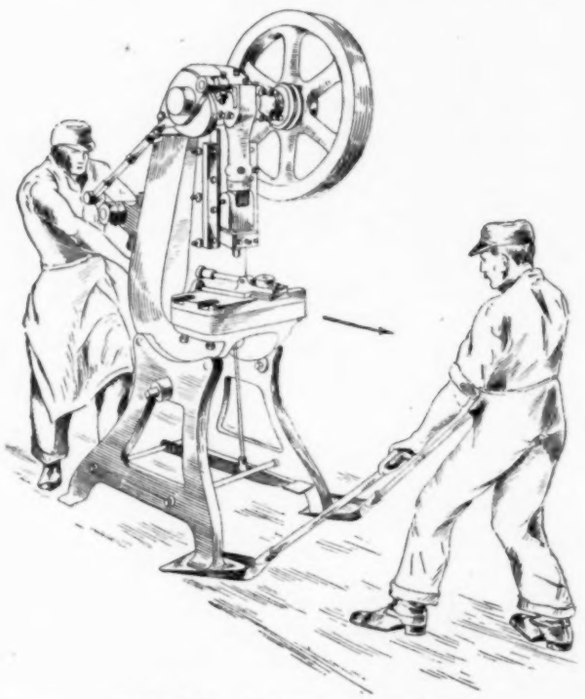
With this method of gathering the links it will be noticed that the burs are all on the same side when they come from the press.

Easy Way to Move Machinery

By S. B. Royal

When a machine, such as a punch press for instance, is to be moved over a wooden floor an easy way to do it is provided by placing ordinary shovels under the two front legs.

While a man or several men, according to the weight of the press, pushes from behind, another man walks



EASY WAY TO MOVE MACHINERY

in front of the machine guiding the shovels, and incidentally the machine, which can be done with remarkable ease by merely turning the handles in the desired direction.

The man in the lead should exert little or no pull on the shovels, as that would serve only to displace them. The effort required to move even quite heavy machinery by this means is surprisingly small.

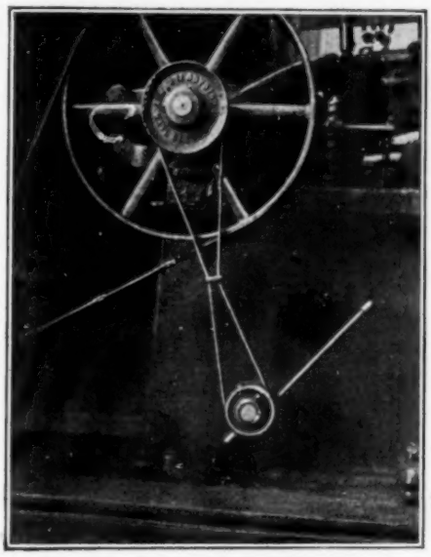
Keeping the Oil-Pump Belt On

By W. T. Delaney

On a battery of 100 metal-cutting saws much time was lost in putting on the little round belt of the oil pump drive, which was continually running off. On a batch of five of these machines in charge of a 16-year-old boy we noticed that no belt repairs were required. Upon investigation we found that the boy had taken a $\frac{3}{4}$-in. pipe and cut off sections about $\frac{3}{16}$ in. thick, slipping the rings over the belts as shown in the illustration. This ring served as a tightener, giving the belt a greater driving angle and preventing it from

slipping off the pulleys. The boy, a foreigner hardly able to speak English, had unknowingly solved a troublesome problem. No doubt a good many other firms have the same trouble.

We improved upon his idea by taking a piece of $\frac{3}{16}$-



TIGHTENER FOR OIL-PUMP BELT

in. round wire and bending it into a ring. The round wire was better than the ring of pipe in that it had no sharp corners by which the belt could be scraped or cut.

A Useful V-Block Fixture

By Herbert M. Darling

A fixture which adds considerably to the usefulness of a pair of V-blocks is shown in the sketch, Fig. 1.

A cast-iron plate planed all over has in it a shallow groove of the right width to fit the V-blocks. Fillister-

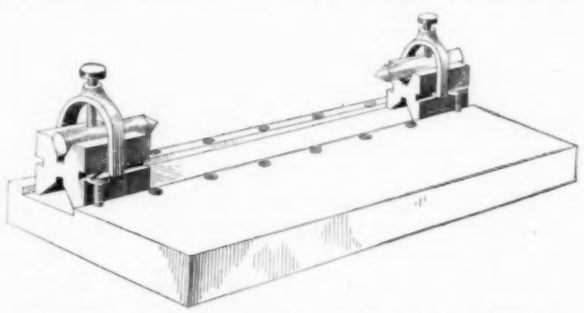


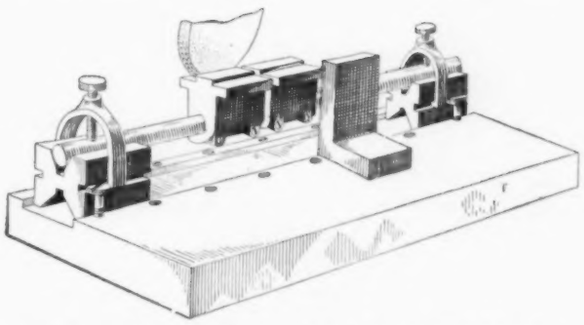
FIG. 1. BASEPLATE AND CENTER FOR V-BLOCK

head screws are used to hold the V-blocks to the plate, the screw heads fitting in the grooves of the blocks.

Centers are made of $\frac{3}{4}$-in. drill rod hardened and ground. Several pairs of screw holes are provided in the plate to hold the blocks in different positions.

Fig. 2 shows a pair of spindle heads used on a gage for aligning the front and rear sights of the Springfield rifle. The spindle holes are lapped and the bases must be ground to bring the holes in line.

I made a bar to accurately fit the holes and clamped the two heads on it, setting it in the V-blocks, as shown in Fig. 2, to grind both heads at once. The fixture is lined up on the grinding machine by placing it on the magnetic chuck against the back stop, and the



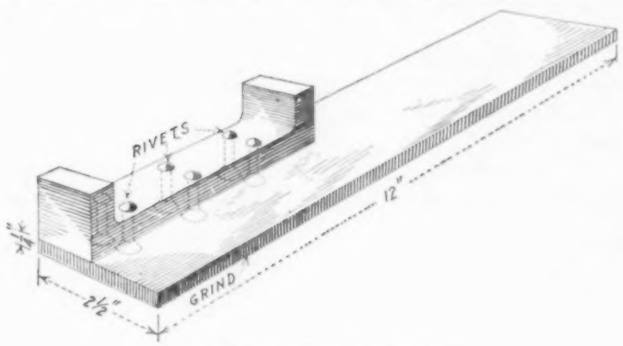
FIGS. 2. GAGE AND METHOD OF GRINDING SAME

angle iron is used as a measuring point, being placed in such a position that a micrometer may be used to measure over the bar and also over the spline, making it an easy matter to grind the spline central with the holes.

How Would You Prevent This Grinding Trouble?

By John Vernon

We have a part which is made, as shown in the illustration, of a piece of cold-rolled steel $\frac{1}{4}$ x $2\frac{1}{2}$ x 12 in. long, to one side of which is riveted a cast-iron bracket, and after the riveting is done we desire to



THE PIECE TO BE GROUND

grind the flush side to a smooth finish over its entire length, including the rivet heads.

We found upon experimentation that the cold-rolled steel would warp under this treatment by reason of the release of surface strains.

Can any reader of the *American Machinist* tell us how to accomplish the operation without incurring this trouble?

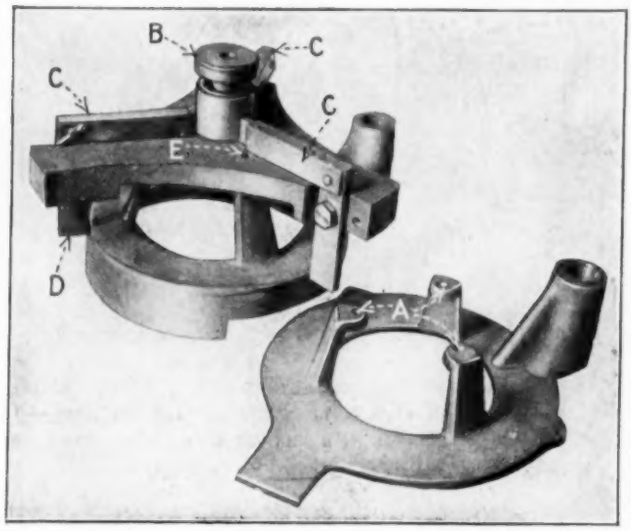
Though the piece is now made of cold-rolled steel, other steel could be used if we could get it with a fairly smooth surface and with the edges square.

Jig for Drilling Wheel-Guard Spiders

By E. V. Allen

The drilling of the holes *A* in the spider arms of the wheel guards shown in the illustration is easily accomplished by using a self-centering and clamping jig. These guards are used on the machines made by the Grand Rapids Grinder Co., Grand Rapids, Mich., and are of two forms, straight and flanged, as shown. The same jig answers equally well for both.

In using this jig it is set down over the casting, and the knurled nut *B*, operating a cone-shaped plug, is



JIG FOR DRILLING WHEEL-GUARD SPIDERS

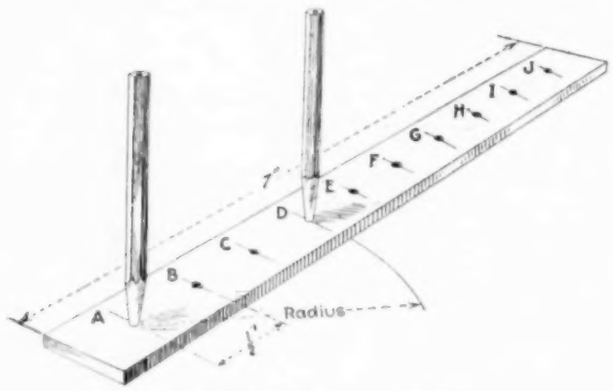
tightened. This causes the slides *C* to move outward and the jaws *D* to clamp onto the work. The holes are then drilled through bushings like *E* set into the jig plate.

Tool for Drawing Circles

BY J. H. MOORE

If a stout piece of cardboard or piece of thin wood about ¾ to 1 in. wide, as shown in the sketch, is carried in the vest pocket, circles will become as easy as straight lines to the sketcher.

For example, by placing one pencil at hole *A* and another in hole *D* a circle of 3 in. in diameter can be



TOOL FOR DRAWING CIRCLES

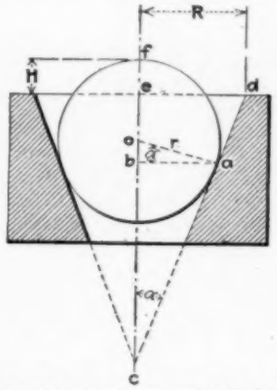
described with ease, and so on as dimensions show. It can of course be elaborated upon by making other lines of holes to draw whatever diameters of circles may be desired. No other explanation is necessary. This tool if once used will become a part of the sketcher's outfit.

Making Some Difficult Duplicate Gages

BY ADOLPH MOSES

On page 162 of the *American Machinist* the making of a master ring gage is described, which has the serious drawback of depending upon a sharp edge for its accuracy. This gage could have been made in one piece by the use of an accurate ball to measure the diameter of the base circle.

This would be done by placing the ball in the conical hole, which had been ground and lapped, and then grind-



MEASURING GAGE BY MEANS OF BALL

ing the base until it was the proper distance from the center of the ball. This distance may easily be computed by means of trigonometry.

Referring to the sketch we have given:

angle $fcd = \alpha$
radius $oa = r$
radius $ed = R$

to find, $ef = H$.

In right triangle oab

$\angle\ oab = \alpha$
$bo = r \sin \alpha$
$ab = r \cos \alpha$

In right triangle abc

$cb = ab \cot \alpha$
$= r \cos \alpha \cot \alpha$
$of = oa = r$
$cf = cb + bo + of$
$= r \cos \alpha \cot \alpha + r \sin \alpha + r$

In right triangle ced

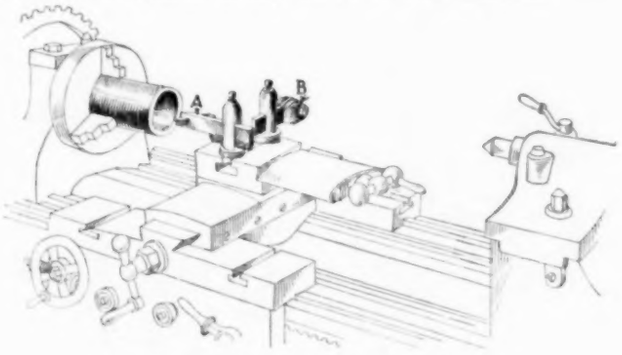
$ce = ed \cot \alpha = R \cot \alpha$
$H = ef = cf - ce$
$= r \cos \alpha \cot \alpha + r \sin \alpha + r - R \cot \alpha$

Parting-Off Piston Rings Accurately

BY F. T. SCHELL

The sketch shows a method for machining piston rings which I think is superior to the one shown by W. G. Datson, on page 1047, Vol. 49.

The tool *A* is used for turning and boring and *B* is the parting tool, which consists of four disk cutters that can be spaced to any width of ring desired.



TOOL FOR CUTTING OFF PISTON RINGS

US
ARMY ORDNANCE NEWS

Modern Artillery Ammunition

By H. M. BRAYTON
Formerly Captain in the Ordnance Department, U. S. Army, Experimental Engineer at Frankford Arsenal

This is the first of a series of articles on the design of artillery ammunition which were written with the idea of aiding the new designer by presenting fundamental principles in as simple a form as possible and free from complicated mathematics. It is hoped that this series will help to prevent some of the natural loss of interest in ordnance topics which will normally follow the signing of the final peace terms.

THE Great War is apparently over and the world will undoubtedly settle back gradually into its old uninterested attitude toward guns, ammunition and other implements of war. Much has been said and written during the past four or five years on these subjects because a knowledge of them was very vital to our national existence. Men realized what a priceless thing a well-equipped and well-trained army really was and how difficult it was to produce up-to-date guns and ammunition on short notice. Prior to this war the general public, including the engineering societies, considered these subjects of interest only to those few officers of the regular service who were assigned to that work.

What will the public of the future know of these things? What interest will the average man or even the average engineer take in these matters in the years to come? These are vital questions now, and the whole future of our nation depends upon them. Will the engineer who is not connected with the army take sufficient interest to spend a little of his spare time in the study of ballistics and gunnery, and will he from time to time submit to the government his ideas on ammunition, or will he forget as the years roll by the great need which this country must meet in this field if it is to keep up with foreign armies?

Much was accomplished during the war in the development of new things to meet the urgent demands of the service. Some of the new things reached the western front in time to be of value to the army. Others were in the process of development. Much has been done of which nothing has as yet been written and undoubtedly much will be kept confidential to the service for some time to come. Yet regardless of all that was accomplished, much still remains to be perfected and many new things are needed before we can safely say that our army is among the best equipped in the world. We are still far behind the other great nations in this respect and it is with a view of creating an interest among the engineers of the country in these vital subjects that this article is written. The writer desires to bring before the public the true state of affairs and to point out how the technical men of the nation can best render a patriotic service by becoming interested.

Wars are not over. History will surely repeat itself. That old and very popular saying "The more we prepare for war the more certain we are to have it" has, I trust, been disproved in the last few years. When it will come next no man living can tell, but it is sure to come, and the one way to delay that day and to shorten it when it does finally come is to be thoroughly prepared for a conflict. Fully prepared here does not mean merely a well-trained army of men, although this is a prime requisite, but it means an up-to-date Ordnance Department with the latest requirements of all branches of the service fully developed and ready to put into quantity production at short notice. It is a well-known fact that it takes a much shorter time to train a man to be a good soldier than it does to design and perfect a new device. Months are required for the latter while a few weeks makes a soldier. Men available for the research and experimental work are few and as a rule must be trained for the work by years of study and practical experience.

The engineers of the country knew very little about the technical side of guns and ammunition before this war. Many were forced to become acquainted with these things during the national emergency through which we have just passed. They have done good work for their country, but they could have done much better work had they been trained or had they had even a fundamental knowledge of ordnance and gunnery. This lack of knowledge was clearly shown in the character of the many ideas submitted on ammunition and guns for the consideration of the Ordnance Department. The majority of these, although many of them came from technical men, were impractical and showed an utter lack of appreciation of the fundamental principles of the subject. Devices were produced which could not possibly function as their designers desired and intended they should, due to the high forces existing in the gun and in flight which had perhaps been entirely neglected.

Most of the forces with which the designer has to deal are simple ones which follow the ordinary laws of mechanics with a precision which is mathematically exact. They are readily calculated by one who is familiar with elementary mathematics. Of course one

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must use higher mathematics for some of the more intricate calculations, but these for the most part need not worry the ammunition designer. The inventor of new devices for ammunition is principally interested in interior ballistics or the forces and conditions existing in the gun during the travel of the projectile.

The writer wishes first to take up in this article a discussion of the fundamental forces which act upon the shell in the gun. His object in doing this is to enable the engineer who wishes to submit his ideas to the government to calculate first the stresses in his design. He may find that they are so great that the

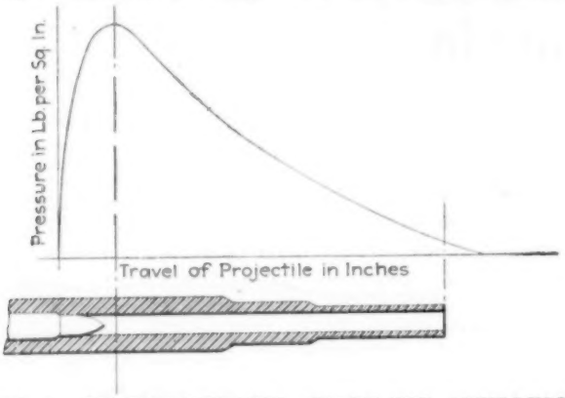

FIG. 1. PRESSURE-TRAVEL CHART FOR ARTILLERY SHELL

mechanism can not operate at all as he desires. The standard textbooks on the subject are so full of mathematics that the average man does not have time to wade through it and pick out the methods which apply to his design. It is the intention to give here in as simple a manner as possible those formulas which must be considered, and not to burden the reader with those which are of interest only in the final analysis.

Every one knows that a shell is projected forward by the action of powder gases exerting a pressure on the rear. This pressure is produced by the rapid burning of some form of powder in the bore of the gun and exists throughout the whole bore of the gun while the shell is traveling outward, although its intensity varies greatly. Fig. 1 shows the pressure curve. It will be noted that the pressure rises rapidly at first and then gradually drops off as the projectile travels forward. The exact shape of this curve will depend on several factors such as the character of the powder, the weight of the shell, and the density of loading which is the ratio between the weight of the powder charge and the weight of a volume of water equal to the powder chamber. It will be noticed that this curve does not reach zero at the muzzle of the gun but extends beyond. This means that the gases exert a pressure on the shell for about 10 ft. beyond the muzzle, an important fact which must not be lost sight of in the design.

All bodies which have mass possess inertia and a shell is no exception. We have in this case a heavy shell acted upon by the gases. The body moves with an ever-increasing speed and we say it has an acceleration. This acceleration can readily be calculated by the formula

$$F = Ma = \frac{Wa}{g} \qquad (1)$$

which is commonly known as the inertia law and in which

F = the total force acting on the base of the shell in lb. = the area of the base multiplied by the intensity of pressure in lb. per sq.in.,

M = the mass of the shell = $\frac{W}{g}$, where W = the weight of the shell in lb. and g = 32.2 ft. per sec. per sec., and

a = the acceleration of the shell in ft. per sec. per sec.

The pressure curve shown in Fig. 1 can be obtained either experimentally or by calculation and from it the value of F in the above formula can be determined. W is obtained by weighing the shell. The value of a can then be found by the formula. It is possible then to plot an acceleration-travel curve which will have the same general shape as the pressure curve. Such a curve would give the acceleration at all points along the bore. Generally however this is not needed and it is customary to consider only the maximum value, which occurs of course at the peak of the pressure curve. This maximum value of the pressure can easily be obtained by means of pressure gages. When tables of acceleration for different guns and howitzers are given, the maximum value is always implied.

The acceleration produces in the shell a condition known to the service as "set-back." This means that as the shell is accelerated, all parts having inertia tend to remain at rest, the effect being to produce severe stresses of a compressive nature in these parts. Any small part within the shell is then subjected to a very severe compressive stress when the gun is discharged, and unless the metal is strong enough to withstand this stress it will deform and fail to perform its proper function. The shell itself is not immune to this force, as all parts front of the driving band must be accelerated. The section of the shell just front of the band receives the greatest stress and this must be kept below the elastic limit of the steel, otherwise the shell will bulge in the bore and perhaps jam and blow up the gun.

The method of calculating this set-back force is very simple. Knowing the acceleration as derived from formula (1) we merely apply the inertia law again as follows

$$F' = \frac{W'a}{g} \qquad (2)$$

where F' = total force of set-back in lb.,

W' = the weight of the part under consideration in lb. and

a = acceleration of the shell in ft. per sec. per sec.

The parts upon which we desire to obtain the set-back are usually small, and it is convenient to have this formula in other units as follows

$$F' = \frac{W''a}{7000 \times 32.2} = 0.00000444\,W''a \qquad (3)$$

where W'' = the weight of the part in grains (1 lb. = 7000 grains). Tables have been worked out by the Ordnance Department giving values of F' (when W'' equals 1) for the different guns and howitzers used in our service. It is often convenient to combine formulas

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(1) and (2) and thus eliminate a and g. The following substitution will show this:

$$F = \frac{Wa}{g}. \quad \text{Therefore } a = \frac{Fg}{W} \text{ (from eq. 1)}$$

$$F' = \frac{W'a}{g}. \quad \text{Therefore } a = \frac{F'g}{W'} \text{ (from eq. 2)}$$

Combining

$$\frac{Fg}{W} = \frac{F'g}{W'}, \text{ from which } FW' = F'W$$

But $F = PA = 0.785\ D^2P$,
where P = pressure in the gun in lb. per sq.in.,
D = diameter of bore in in.
We can then substitute this value for F and obtain

$$WF' = 0.785\ D^2PW' \qquad (4)$$

Or we may prefer this formula in terms of W'', when it becomes

$$F' = \frac{0.785D^2PW''}{7000W} \qquad (5)$$

If we make $W'' = 1$ grain, this becomes a simple four variable equation of the product type,

$$F' = \frac{0.000112D^2P}{W} \qquad (6)$$

This formula is used so much and is of such great importance to the designer of ammunition that the writer has deemed it worth while to build it up in the form of a graphical chart from which any one of the four variables may be obtained very quickly and without calculation when the other three are known. Such a chart is shown in Fig. 2. It is designed to cover the usual range of the variables which enter into the formula. The values of D, P and W are the ones usually known, with F the unknown. It is then only necessary to connect the known values of D and P and by means of a straight edge marking the point of intersection with the center vertical which carries no scale. Then connect this point with the value of W found on its scale and this line prolonged will cut out the true value of the set-back, F', in lb. per grain on the outer scale. The chart illustrates by means of the dot-dash lines the method of using the chart. The case taken is that of the 4.7-in. field gun, the projectile of which weighs 60 lb., and the maximum pressure reaches a value of 35,000 lb. per sq.in. The chart shows a set-back equal to 1.44 lb. per grain. In order to get the total set-back it is of course necessary to multiply this value by the weight of the part in grains. It must be remembered that this value is the maximum and occurs only at the peak of the pressure curve. Furthermore, this stress exists for a very short interval of time. If ammunition is designed on this basis, however, it is on the safe side and no trouble will result.

Fig. 3 gives a similar chart for obtaining the set-back produced in smaller caliber guns such as the rifle and machine gun. This chart also covers the modern 11-mm. gun. The method of reading is exactly the same as described above for Fig. 2. The dash-dot lines show that it is necessary to connect the value of W in grains with P. Then through the value of D and the intersection of the first line with the diagonal a line is drawn which will cut out the proper value of F'. The cross lines here drawn show the condition in the small arms service rifle where $D = 0.30$ in., $W = 130$ grains, $P =$ 42,000 lb. per sq.in. and $F' = 22.8$ lb. per grain. This chart is built up on the formula

$$F' = \frac{0.785D^2P}{W} \qquad (7)$$

where W = weight of the bullet in grains.
It will be noted from the above discussion that the force of set-back is very much greater in small arms design than in artillery.

Such mathematical values of these various variables pertaining to the different guns as the civilian engineer may require in carrying out such calculations as the above may in most cases be obtained from the Ordnance Department in Washington. It is usually necessary, however, to show that they are desired for a legitimate

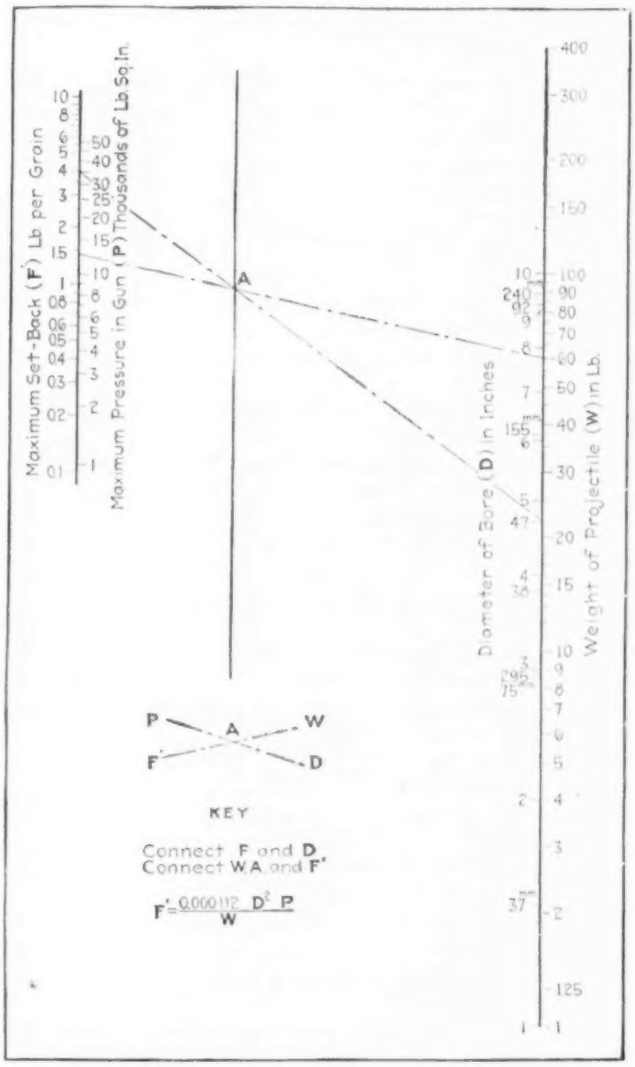

FIG. 2. INERTIA CHART FOR ARTILLERY AMMUNITION

purpose. Such values as the diameter of the bore, powder pressure and weight of the shell are usually widely known and are readily obtained.

The reader may have been led to believe from the above discussion that the force of set-back was always a hindrance to the designer and something not desired. Often this is the case, but regardless of its destructive

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properties it is much used in modern ammunition. Many fuses, especially of the smaller and less complicated designs, rely upon set-back for their operation. It is a common thing to make the set-back release safety catches and start time fuses functioning.

Set-back forces are, generally speaking, smaller in large guns than in small ones and practically always lower in howitzers and mortars than in guns of the same caliber. This is due to the higher pressures carried in the guns. Set-back is sometimes spoken of as the "shock of discharge." As such it often causes trouble

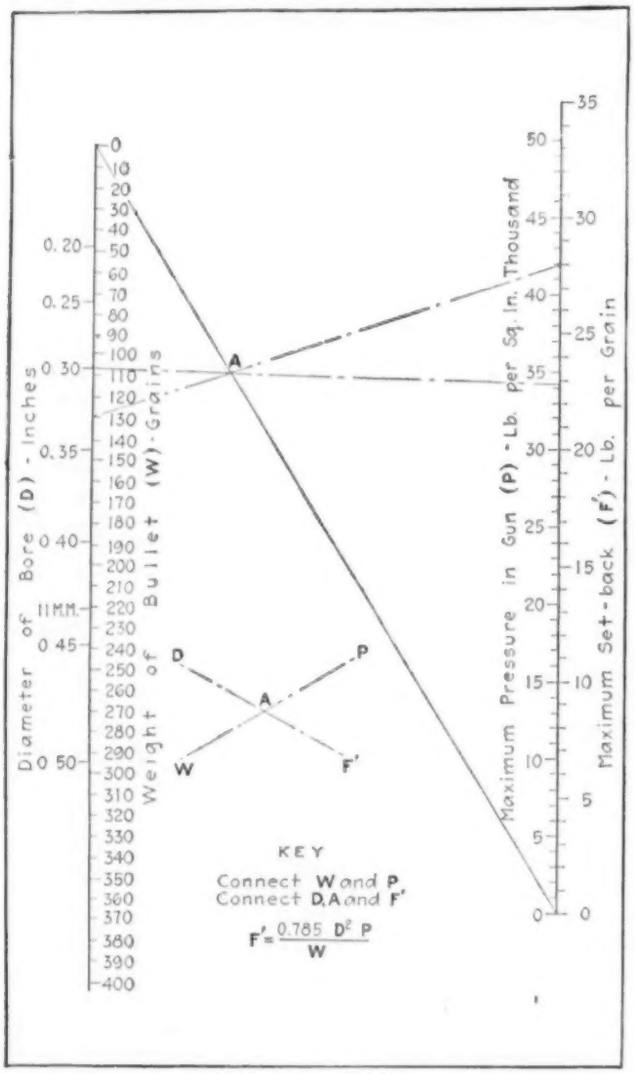


FIG. 3. INERTIA CHART FOR SMALL ARMS AMMUNITION

with the sensitive explosives such as mercury fulminate used so extensively in detonators. It is a well known fact among ammunition designers that a column of fulminate greater than ¾ in. long will explode in the 3-in. field gun upon discharge. This fact in regard to the effect of set-back must always be borne in mind when designing parts to carry the super-sensitive explosives.

It will be readily appreciated from the above discussion that all devices which are to be put on shell must be designed for the gun in which they are to be fired. This is one of the reasons why so many different types of fuses are needed in the service and why one fuse can not be obtained to fit all guns and howitzers.

In succeeding articles the writer will discuss the other forces acting on the shell in the gun and in flight, after which he will give a description of some of the new things which were developed by the experimental department at the Frankford Arsenal during the war. The reasons why these new things were needed and their manner of use will also be taken up. These articles are certified by the chief of ordnance before being published.

PERSONALS

First Lieut. D. S. Anderson, of 1720 Beacon St., Brookline, Mass., has been discharged after 13 months' service. He was formerly with the Henley-Kimball Co., Boston, Mass., and has served as inspector of ordnance.

* * *

Lieut.-Col. William Libbey, who was commissioned in February, 1918, and has acted as chief rifle demonstrator, has been discharged. He is a graduate of Princeton, and before entering the service, was a professor of modern languages at that university.

* * *

Capt. S. W. Horner, of Germantown, Penn., who was commissioned first lieutenant in February, 1918, and has been on duty in the Engineering Division, has returned to civil life. He was graduated from Dartmouth in 1907, and has been employed by the Eastern Motor Corporation, Pennsylvania.

* * *

Maj. John J. O'Connell, who was commissioned captain in 1917 and has been on duty in the Rochester district office, has left the service. He is a graduate of the University of California and a hydraulic engineer, being formerly employed by the Electric Bond and Share Co., 71 Broadway, New York.

* * *

Capt. Harry B. Johnson of Springfield, Mass., has left the service. He was commissioned in January, 1918, went to France in February, and has just returned. His work there was with the Finance Division, for which his previous experience with Harris, Forbes & Co., Investment Securities, fitted him.

* * *

First Lieut. Paul W. Engelhardt, who was commissioned in November, 1917, has returned from abroad and left the service. He acted as machine-gun instructor and was for a time attached to the 111th Mobile Ordnance Repair Shop. Lieutenant Englehardt was formerly in the employ of the Oldsmobile Co., 1806 Broadway, New York.

* * *

Maj. Malcolm S. Huey, Princeton graduate, who was recently discharged, was commissioned captain in December, 1917. His service has been entirely in personnel work, first in the Supply Division in Washington and later, overseas. Before Major Huey was commissioned, he was with William A. Read Co., Investment Securities, Philadelphia, Penn.

EDITORIALS

Never Mind Who Makes the Tonic

AN INTERESTING comment on the desire of France to do most of its own reconstruction work is found in the Paris edition of the New York *Herald* for Feb. 25. This is in the nature of a warning given by Judge Walter F. Berry, president of the American Chamber of Commerce of Paris. He quotes a typical case as follows:

"A French industrial in the north, whose textile machines were stolen and carried to Germany, recently placed an order in the United States for new machinery. These being now completed, he applied for an importation permit. It was refused on the ground that he must have his looms built in France. He replied that such looms had never been made in France; that special machinery is necessary to make them; that such special machinery is only built in the United States and in Germany, in which latter country, by the way, these old machines had been purchased. He added that if the permit were granted, his factory would be employing several thousand workmen within six months and would be producing materials for exportation."

* * *

It would be poor judgment for one who had suffered a severe sickness to refuse to take a tonic that would make him well simply because it was concocted by a druggist living outside of his block. A tonic that will make industrial Europe get on its feet quicker than anything else consists of American labor-saving machines.

Rehabilitation of the War-Maimed Returning Fighter

WE READ a great deal about the excellent work being done by the Red Cross Institute and other organizations in furnishing the maimed fighters with artificial limbs that will in part remove their disabilities; we see pictures of the maimed at work after being fitted with such aids; we read of the establishment of schools for the vocational training of the maimed in different parts of the country. All these things are excellent and are moves in the right direction but they must be followed by something more tangible—employment for the maimed—and of this we hear little or nothing.

* * *

The daily press has assured us from time to time that work was to be furnished to all our disabled fighters so that they might not want. Where are these jobs and does anyone know of a maimed soldier or sailor having been given actual employment?

A report comes from Chicago that the general superintendent of a large mail order house has completed a survey of his plant and that he has found jobs that can be satisfactorily filled by men having every kind of disability. Has he placed any of our disabled men in these jobs?

Surveys have been made without number, but surveys are preliminary and may mean much or they may mean little, but what about the actual job for the maimed.

Approximately 200,000 of our oversea forces are disabled, about half of them are suffering from wounds and half from diseases contracted in service. Of these about 196,000 had been brought back to the United States up to Mar. 1, and the small contingent now in France will soon be here.

* * *

What are we going to do with and for them? They don't want charity, they don't want pity; they want employment at a living wage that they may support themselves and those dependent on them.

How many mills, factories, stores and offices are there in these United States? If each one of these establishments would agree to furnish employment for one disabled soldier, there would not be enough disabled soldiers to fill all the positions offered.

* * *

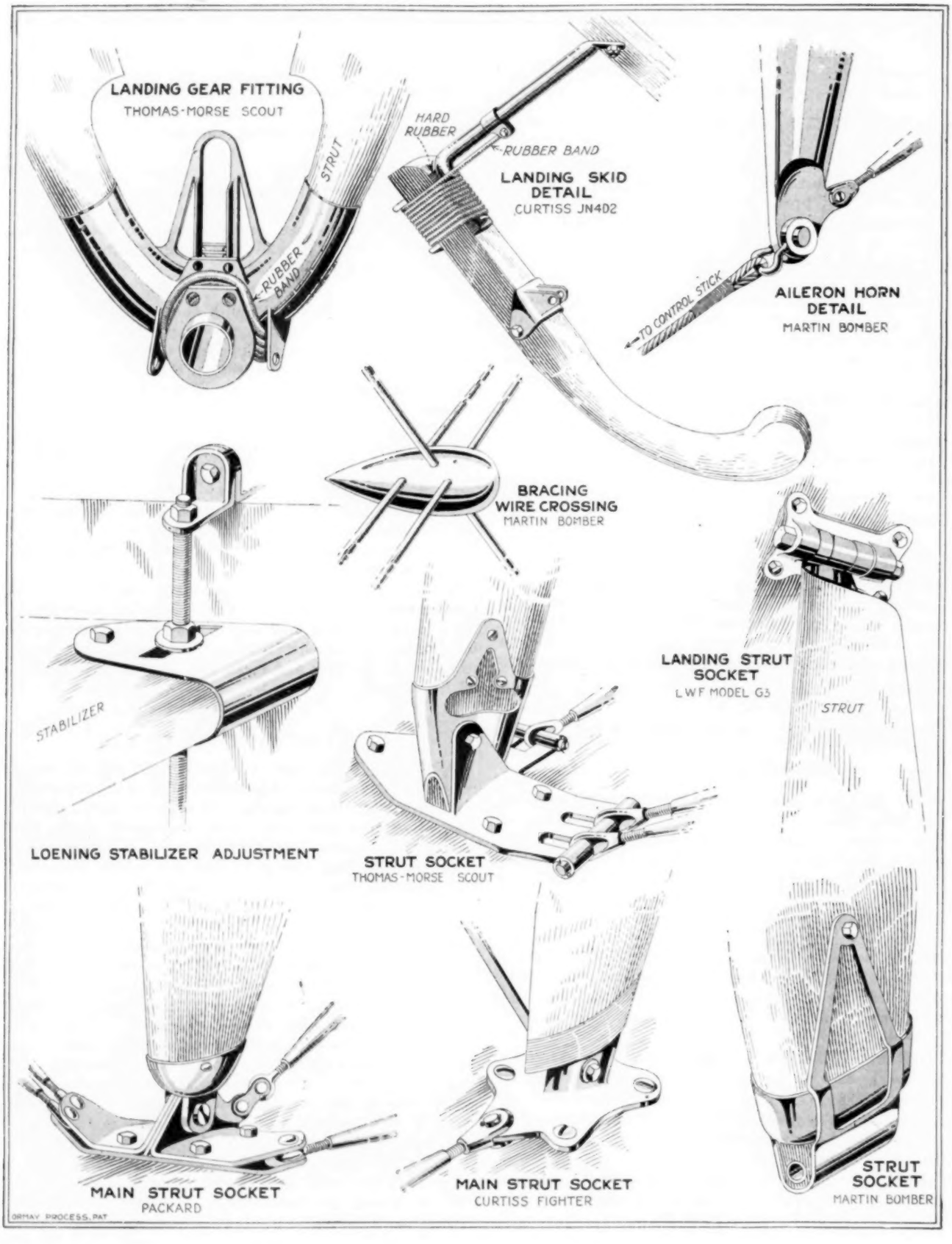
Are these men going to be given work or must we see reënacted such scenes as took place after the Civil War—maimed soldiers rattling pennies in tin cups at the street corners.

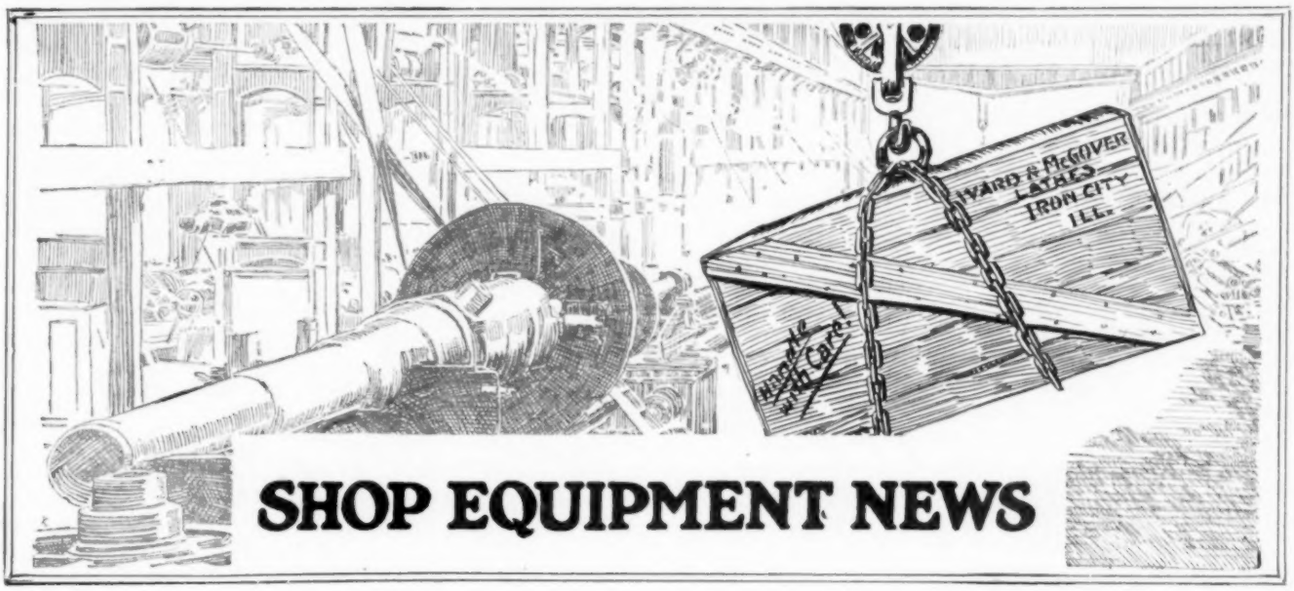
Get busy, Mr. Manufacturer, make surveys if you choose, but in Heaven's name find a job in your plant for a maimed soldier, and give it to him, not grudgingly but cheerfully, as cheerfully as he crossed the ocean to help lick the Hun and make this country safe for all of its citizens.

How to Sell Now

ONE big factor that is retarding the sale of many of the manufactured products today is the argument that price reductions are due. If salesmen can convince the buyer that prices will hold reasonably stable for the next few months, most of them will do a very good business. During the last year for which statistics are available, the total value of products manufactured in this country was $24,246,000,000. Of this total, raw materials constituted about 60 per cent.; rent and taxes 2 per cent.; depreciation, interest, and profits 16 per cent.; and labor, the important item of 22 per cent. In view of the labor difficulties facing the country at the present time, there seems little immediate chance of labor costs being cut down appreciably. Neither will rent, taxes, interest, or depreciation show radical reductions. Leaving profits out of the discussion, the remaining item is raw materials, which makes up somewhat over 50 per cent. of the total cost. This means that if the cost of the finished product is to drop 1 per cent., the average cost of the constituent raw materials must drop 2 per cent. Furthermore, it is difficult to reduce the price of a finished product as soon as raw materials go down; there is usually a time lag. These facts should be presented to the reluctant buyer.

Some Typical Metal Fittings Seen at the Aeronautical Exposition





SHOP EQUIPMENT NEWS

Schmidt-Norgren Duplex-Spindle Plain Turning Lathe

The illustrations show a duplex-geared-spindle, plain turning lathe which has been developed with the object of providing means for turning small-diameter work between centers and operating on two pieces simultaneously. The idea is particularly to provide for the turning of such pieces as cannot be turned on automatic screw machines because they are too long or must be centered for final grinding operations. A number of cutting tools for turning both straight and tapered work can be fitted and back tools can be provided for necking and undercutting operations. This machine is the product of the Schmidt-Norgren Co., 3121 South California Ave., Chicago, Ill., and is at present made in one size and type swinging 10 in. over the ways and 6 in. over the cross-slide with a capacity of 24 in. between centers.

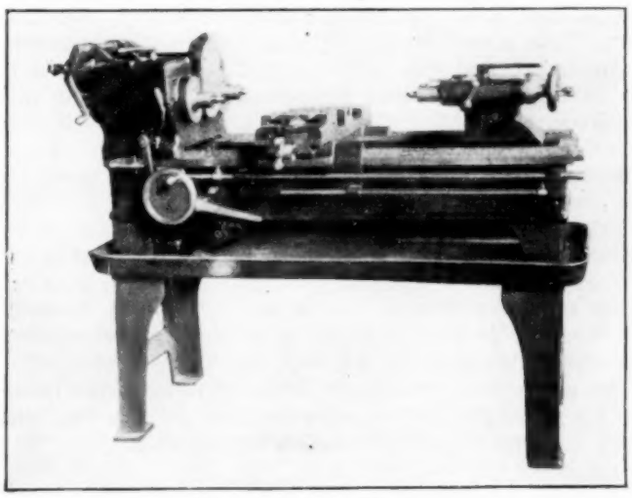


FIG. 1. THE DUPLEX-SPINDLE PLAIN TURNING LATHE
Weight, 1300 lb.; length of bed, 56 in.; floor space, length, 62 in., width, 39 in.; height, 52 in.; drive pulley diameter, 6½ in., face, 3½ in., speed, 420 r.p.m.; maximum distance between centers, 24 in.; swing over bed, 10 in.; swing over cross-rest, 6 in.

The bed is of heavy design with a double vertical wall or web on each side forming a hollow column extending the full length on each side of the center line. A cast-iron chip and oil pan is provided a short distance below the bed. Fig. 1 gives a general view of the front of the machine. Two spindles are carried in a widened headstock, and a widened single tailstock base carries two distinct tail spindles each of which is operated by an individual handwheel.

The carriage is provided with a double cross-slide with two wide toolpost surfaces, one for each spindle, these surfaces being provided with T-slots. The rear toolpost rest is carried on the main body of the cross-slide, while the front toolpost rest is a separate casting, fitted to a separate slide on the main cross-slide and operated by its individual cross-feed screw, the crank handle of which may be seen directly above the handle of the main cross-feed screw. This arrangement permits the tools for the two spindles to be adjusted separately, to the extent at least that after adjusting the rear tool carried on the portion of the main cross-slide, the front tool can be set in place. Conversely the front tool may be removed and readjusted without disturbing the rear tool. At times when one spindle is used for roughing and the other for finishing the front spindle should be used for finishing, as more frequent adjustments are of course necessary in this class

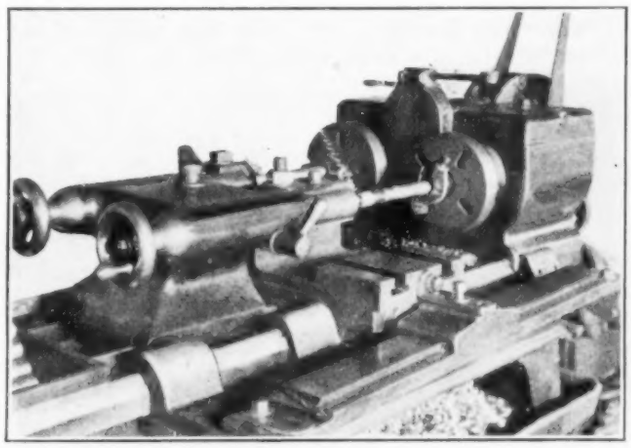


FIG. 2. TAPER-TURNING ATTACHMENT IN SERVICE

of work. The carriage is also provided with a taper-turning attachment which can be seen in service, Fig. 2.

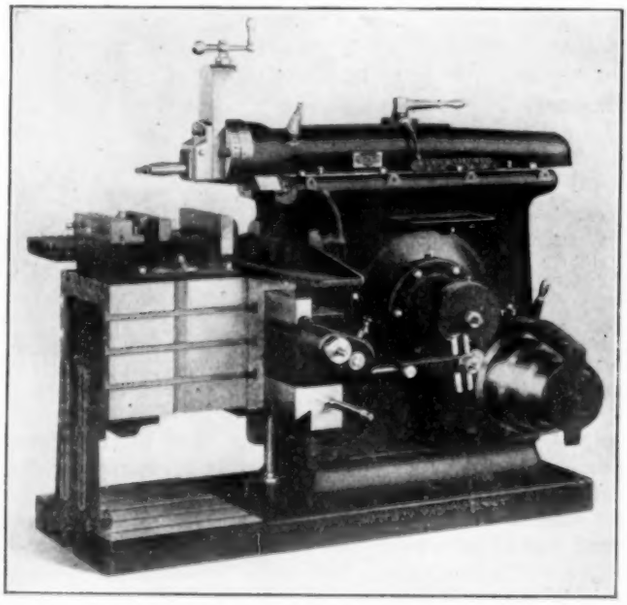
The spindles which are 10 in. apart to leave room for tooling between them, are equipped with SKF ball bearings and thrust bearings. The drive from the single-belt pulley is controlled by a friction clutch operated by the upper left lever, Fig. 1. There are four speeds, 150, 190, 230 and 280 r.p.m., when the pulley is driven at a speed of 420 r.p.m.

The ends of the spindles are designed to permit the use of pneumatic chucks. The head is constructed as an entirely inclosed casting so that the gearing may run with this chamber partially filled with oil. The gear shifting is done by means of the handle on the top of the head which operates a square-tooth clutch.

Standard screw-feed is used for the carriage and this feed is provided with an automatic knock-out rod which will be noted as the upper rod extending across the front of the tool carriage. In disconnecting the screw-feed this knock-out rod throws in the hand-feed by which the carriage can be advanced any slight distance that may be necessary to reach a positive stop carried on the lower rod when working to close limits. When the knock-out trips the feed it also operates a square-tooth clutch, and by a spring arrangement automatically engages the hand-return which operates through spiral gears.

Mattison 20-In. Shaping Machine

The 20-in. high-duty shaping machine shown in the illustration is being marketed by the Mattison Machine Works, Rockford, Ill., and is said to be of such construction that it will stand up under the heaviest type of work. The column is wide and deep and is ribbed and provided with a large base. The main bearing for the bull gear is in the form of a heavy bushing pressed into a machined recess in the column and securely locked in place, this construction eliminating dowel pins and bolts that are customarily used to secure this bearing in place. Two diameters of bearing for the bull gears are provided in this bushing, to prevent breakage at the shoulder of the gear. The table is rugged, the top surface of the table proper measuring 16 x 17 in., but by removing the dust guard, the available working space may be increased to 16 x 22 in. The T-slots are machined from the solid. The table support is another feature that is stated to be unusual. The base is extended beyond the outer edge of the table and the sliding surfaces are under the table out of the way of dirt. The construction also prevents upward vibration as well as downward.



MATTISON 20-IN. HEAVY-DUTY SHAPING MACHINE

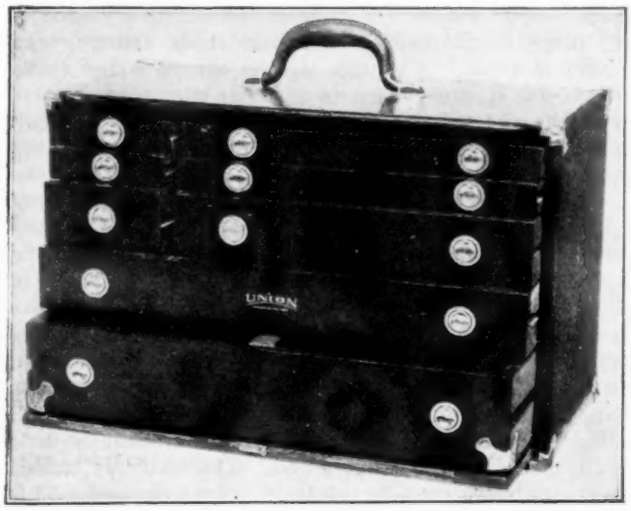
Actual length of stroke, 21 in.; horizontal travel of table, 24 in.; vertical travel of table, 15 in.; maximum distance from table to ram, 18½ in.; maximum distance from base to ram, 38 in.; top of table, 16 x 17 in.; top of table, including apron, 16 x 22 in.; depth of table, 15½ in.; down-feed to head, 7 in.; diameter of head, 8 in.; length of ram without head, 46 in.; ram bearing in column, 37 x 11 in.; crossrail bearing on column, 16 x 20 in.; keyseating capacity, 3½ in.; size of vise jaws, 2½ x 12 in.; opening of vise, 12¼ in.; size of tools, ¾ x 2 in.; cone pulley, 8 to 14 in. in diameter, 4 step, with 3¼-in. laces; tight and loose pulleys on countershaft, 14 x 4¼ in.; speed of countershaft, 330 r.p.m.; speeds of ram, eight, 8 to 100 strokes per minute; single gear ratio, 7 to 1; back gear ratio, 26 to 1; size of base, 24 x 66 in.; floor space, 48 x 92 in.; weight for domestic shipment, 4800 lb.

The vise is of the planer type, and is quick-acting, the jaws being steel-faced. It can be tilted for holding tapered work and is prevented from tipping by means of clamp screws. A graduated swivel base is incorporated. The crossrail is bolted directly to the frame of machine, eliminating gibs and securing greater rigidity. Tension bolts are provided to prevent the crossrail dropping away when the locking bolts are loosened. The mechanism for regulating the cross-table-feed can be adjusted while the machine is in motion, and a friction safety device is provided to protect the feed mechanism from damage, should the cross-feed accidentally meet with any obstruction. The elevating screw is of the stationary type and operates through bevel gears on a ball thrust bearing. It is entirely contained within the machine and does not project through the floor.

The ram is long, well-ribbed and mounted on V-ways of 45-deg. angle, a feature that is said to increase the life to a considerable extent. The ram has a screw adjustment and can be positioned while the machine is in motion. A balanced construction is used for the rocker-arm enabling the use of a heavy arm without placing any undue weight or wear on the ram. It is claimed that this construction eliminates vibration to a great extent and almost entirely does away with chatter marks under heavy cuts. Another feature is the rocker-arm driving block, which is provided with an adjustment within itself, doing away with play or slap on the rocker-arm slide and insuring a smooth motion to the ram. A special oiling feature insures positive lubrication to the slide and driving pin. The cone pulley runs on a large sleeve mounted in the base, and a guard protects the operator and also prevents the belt from running off the cone when shifting.

Union Garage Tool Chest

The Union Tool Chest Co., Inc., Rochester, N. Y., has just placed on the market the tool chest illustrated, which is intended especially for mechanics and shops doing automobile repair work. The chest is made of kiln-dried oak, is lock cornered and has glued joints, the backs of the chests being rabbitted or shouldered to the frame as well as glued and nailed in place. Metal corners are used to protect against damage. The handle is covered with leather and has a heavy steel wire through the center, the weight being carried by rivets extending through the top of the chest. The drawer pulls are of the flush type set into the front of the drawer and do not detract from the drawer space. The bottom drawer or tray is fitted with a handle that drops down into the drawer when not



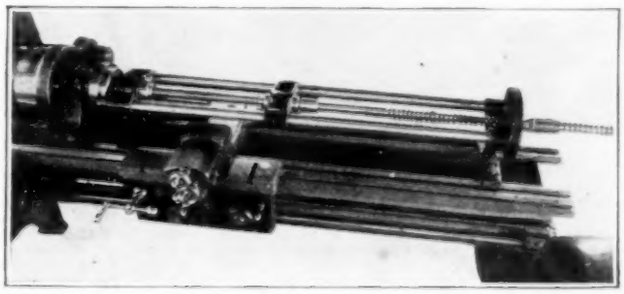
UNION GARAGE TOOL CHEST

Two drawers, 4 in. long, 7⅞ in. wide, ⅞ in. deep; one drawer 4 in. long, 7⅞ in. wide, 2⅛ in. deep; two drawers, 12¼ in. long, 7⅞ in. wide, ⅞ in. deep; one drawer, 12¼ in. long, 7⅞ in. wide, 2⅛ in. deep; one drawer 18¼ in. long, 7⅞ in. wide, 2⅛ in. deep; and one tray 18 in. long, 7⅞ in. wide, 3⅛ in. deep. Outside dimensions, 20¼ in. long, 9¼ in. wide, 13¼ in. high. Weight, 23 lb.

in use, this serving as a handy tray to contain tools actually in use on the job. The drawers run on hardwood slides set into the ends of the frame and will carry any weight which may be put into them. The bottoms are three-ply veneer tongued to the sides and front. The two small drawers at the top are fitted with movable partitions and one of the long drawers is partitioned for a socket wrench set.

"Velco" Broaching Attachment for Lathes

The V. E. La Pointe Manufacturing Co., 17 Hungerford St., Hartford, Conn., has just placed on the market the broaching attachment shown in the illustration. This is for use in connection with an ordinary engine lathe, and is intended for use in small shops where the expense of a regular broaching machine would not be warranted. The device consists essentially of three heads, one sliding and two stationary. The latter are provided with bases that rest on the ways of the lathe and are held a fixed distance apart by means of the two cylindrical compression members shown at each side. The sliding head at a center serves as a guide for the screw and the broach, and also holds the mechanism connecting these two parts. The screw is connected to the sliding member by means of a pin which prevents the former from turning. It should be understood that the lathe spindle serves simply as a means of driving the attachment, and does not carry any of the thrust which is taken up in the two cylindrical compression members. The bronze nut which moves the screw lengthwise is carried in the head at the left. This head is held in place in a longitudinal direction, ball thrust bearings being used, and is driven from the regular lathe faceplate by a ball screw arrangement that takes care of any slight misalignment between the lathe spindle and the screw. It will be seen that the machine has as many speeds as are incorporated in the lathe, and when the lathe spindle turns, the bronze nut is turned on the screw, pulling it back to the left through the hole in the spindle of the lathe. A pulling sleeve inside of the sliding head connects the screw and broach holder, and this device and the work bushings are so constructed that the center line of the lathe spindle is in line with the cutting edge of the broach when a one-sided broach is used, this method obviating cramp. The work face has a 4½-in. hole, reducing bushings being used of any size desired. The diameter of the screw is made as large as may be conveniently passed through the hole in the lathe spindle, small screws being hardened and tempered. The standard length of stroke is 48 in., but other lengths can be made if desired. The diameter of the compression members is 1¾ in. The bases of the two stationary heads can be either furnished blank or machined to fit the ways of the lathe if templets are sent.



LA POINTE BROACHING ATTACHMENT FOR LATHES

Arnold Electric Drills

The Arnold Electric Tool Co., Inc., 902 Chapel St., New Haven, Conn., has just placed on the market the two types of electric drills shown in the illustrations. Fig. 1 shows the precision bench drill, which is of the sensitive type, and mounted on double trunnions in such a manner that the complete unit of motor and drill can be swung at any desired angle to the table. Graduations are provided on the trunnions so that the drill can be set quickly to any angle, after which it is

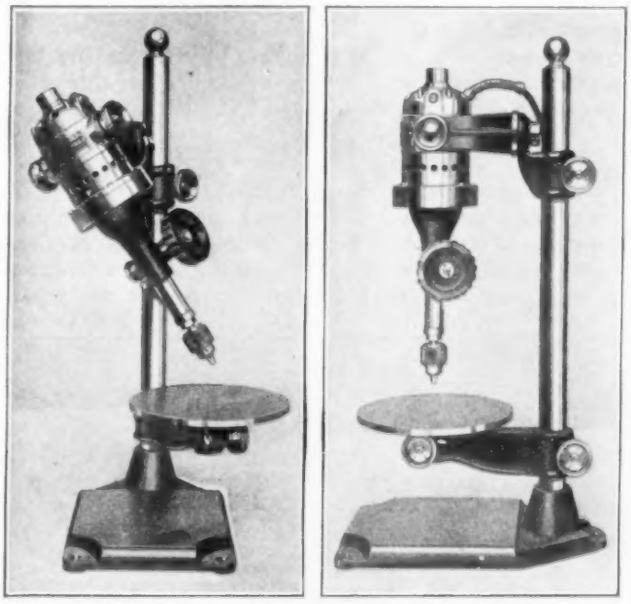


FIG. 1. THE ARNOLD PRECISION BENCH DRILL

Base, 12 x 8 in.; distance from center of table to post, 4⅝ in.; diameter of table, 6½ in.; total height, 23 in.; feed, rack and pinion type with 1½-in. travel; clearance from base to bottom of shaft, 11 in.; capacity, ¾ in. in steel; weight, 30 lb.; motor equipment, Hamilton Beach universal type, 110-120 volt, 25-60 cycle; chuck, Jacobs.

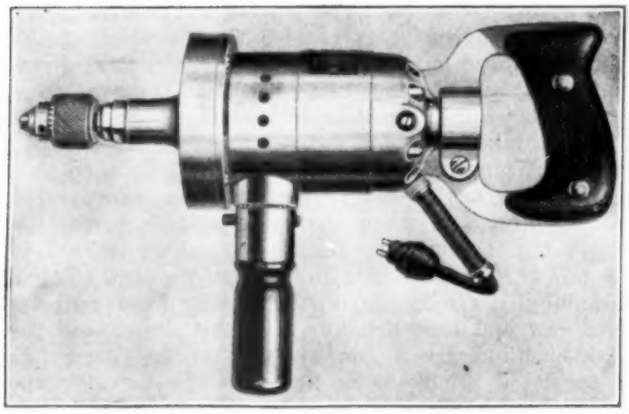


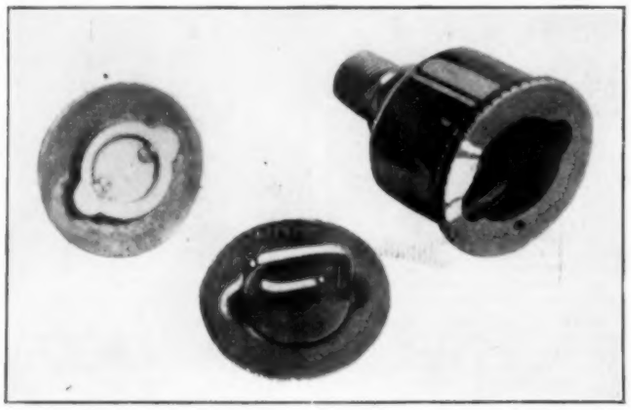
FIG. 2. TYPE-A PORTABLE HAND DRILL.
Length over all, 13 in.; weight, 6 lb.; capacity, ¼ in. in steel; motor, universal type, 110-120 volt, 26-60 cycle; chuck, Jacobs.

locked in place by means of knurled hand screws. The base is machined and scraped square with the column, which is fastened to it by means of a large nut. Both the table and motor brackets slide on the column, being locked in place by means of hand screws. The table is fastened to the arm by a turned stud which fits the arm socket and is secured by a screw, allowing the table to be locked in any position desired. The feed mechanism is of the rack and pinion type, but a small lever has been substituted for the handwheel shown. A Jacobs chuck is used as regular equipment. The chuck spindle is hardened and ground and runs in bronze bearings.

Fig. 2 shows the type-A portable hand drill for use on either metal or wood. The motor runs at high speed and the reduction gearing is of the planetary type, giving a six to one reduction. The transmission is inclosed in a tight aluminum case, and either grease or heavy oil is used to insure proper lubrication. A pin-operated switch is mounted in the handle at the side of the motor. The handle at the rear can be removed in case it is desired to replace it with a taper shank, so that the drill can be used in the tail spindle of a lathe.

"Rohr" Grease Cups

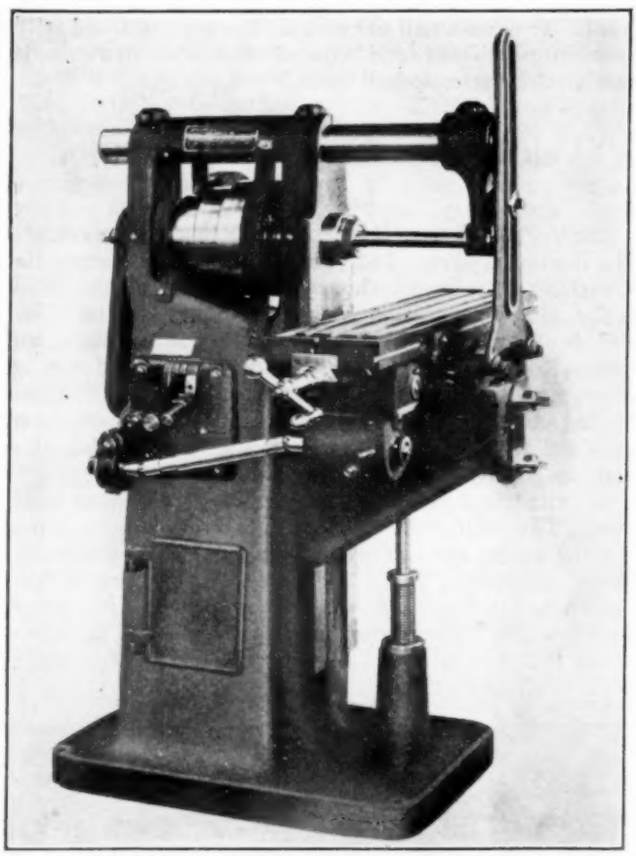
The "Rohr" grease cup shown in the illustration is being manufactured by the Tes-Tite Piston Ring Co. Freeport, L. I., and is being marketed by B. E. Carpenter, 1328 Broadway, New York. The best features of this cup are, that as the top cannot be taken off, there is no danger of losing it or crossing the thread in trying to replace it, and the fact that there are no coil springs, ratchets or other complicated parts to get out of order and cause trouble. To fill the cup it is simply necessary to turn it to the left with the thumb and finger by means of the handle until it comes to a stop, when the cover will turn in the cup-body and come off. After filling the cup with grease, the cover is simply pressed down tightly and turned to the right, the first half-turn serving to secure the cover in place while further turning places pressure on the grease. The cover is held in place by a flat spring having two ears. The handle should always be used when turning the top or body. This will insure the cover being locked when screwing down on the body, and will unlock it when being unscrewed before damage is done to the threads at the lower end. The latter is turned over slightly to prevent the body being removed. This feature prevents the top being lost.



"ROHR" GREASE CUP

Davenport No. 2-B Plain Milling Machine

A photograph is shown of the new Davenport No. 2-B plain milling machine (back-geared) built by the Davenport Manufacturing Co., Meadville, Penn. The table of the machine has three ⅝-in. T-slots and is all working surface. It is mounted on extra-wide bearings



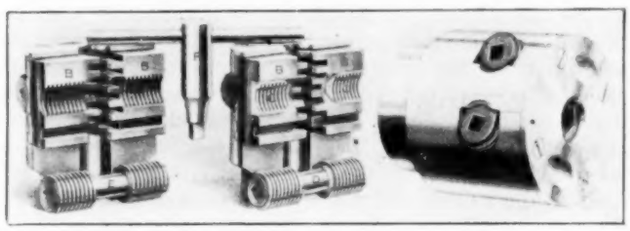
DAVENPORT NO. 2-B PLAIN MILLING MACHINE

Table, 38 x 10 in.; longitudinal movement, 23 in.; cross movement, 9 in.; vertical movement, 19 in.; spindle, 2¼ in. diameter x 4⅝ in. long in ground bearing; No. 10 B. & S. taper hole; 1⅛ in. hole through; 2¼ in. diameter nose, threaded 10 per in.; three-step cone; 12 speeds; back gear ratio, 4.57 to 1; feed box, 12 changes; tripping mechanism plunger type; overhanging arm steel bar, 3¼ in. diameter; countershaft, two speeds; 10 x 3½ in. pulleys; arbor, 1 x 10 in.; vise, steel jaws, 6¼ x 1½ in., 3½ in. opening; equipment—vise, 1-in. arbor, end support brace, wrenches and overhead works; weight, 1900 lb. net; 2000 lb., domestic shipping; 2250 lb., export.

and fed by a screw giving ¼ in. of movement per turn of the handle. Another crank at the end of the table gives a quick return at the rate of 1¼ in. per turn. The spindle is made of forged crucible steel and runs in adjustable phosphor-bronze boxes. Hardened and ground thrust collars are fitted and lubrication is from oil reservoirs cast in the bed. The driving cone has steps of 7.73, 8.86 and 10-in. diameter for a 2½-in. double belt. The spindle speeds are 20, 27, 35, 45, 59, 77, 95, 123, 160, 204, 270 and 350 r.p.m., and the feeds per revolution of spindle are 0.004, 0.006, 0.009, 0.010, 0.011, 0.014, 0.018, 0.019, 0.023, 0.027 and 0.047 in. The feed-box gears are alloy steel and the drive is by roller chain from the spindle. Reversal of the feed is through a push rod on the feed box and all parts of the mechanism are oiled from one large oil pocket which is filled through an opening in the column. The tripping mechanism is of the plunger type and the under side of the overhanging arm is 6¾ in. from the spindle center line. The countershaft speeds are 123 and 27 r.p.m. and the clutch pulleys are self-oiling. The 1 9/16-in. shaft runs in self-oiling bearings. The arbor is made of 70-point-carbon chrome-nickel steel, heat-treated, and has a ball-bearing end support. Adjustable dials graduated in thousandths of an inch are provided for longitudinal, cross and vertical movements.

Casler Twin-Screw Drill Chuck

The Marvin and Casler Co., Canastota, N. Y., has brought out the drill chuck shown, which is claimed to have a grip on a drill double that of the single-screw type, thus permitting the drill to be forced to the limit of its strength. The body is made of close-grain cast

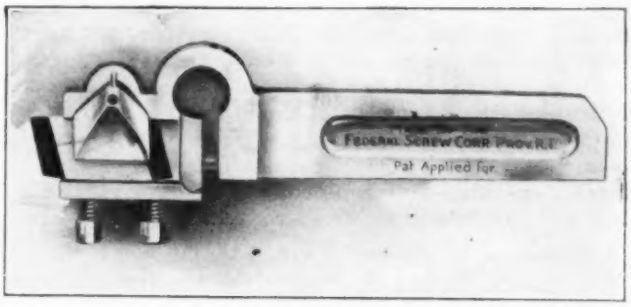


CASLER TWIN-SCREW DRILL CHUCK

iron and the jaws and screws of tempered high-carbon steel. This combination is said to give long life to the wearing surfaces. The body is reinforced by a steel cap plate to prevent it from spreading under strain. When using the chuck the primary screw *E* is first operated to grip the drill shank between the jaws *B*. The secondary screw *D* is then operated so as to bring the floating nuts *C* against the ends of the pockets in the jaws. All parts are said to be interchangeable and the chuck is relatively free from projections.

Federal Spring Toolholder

The toolholder shown in the illustration is built with a goose-neck to add flexibility to the cutter with the idea of eliminating chatter. It is marketed by the Federal Products Corporation, 393 Harris Ave., Providence, R. I., and is intended for holding thread cutters. Three cutters are furnished, one for cutting at right angles to the stock and the others for offset cutting to a shoulder, one right and the other left. One end of each cutter is ground for roughing and the other

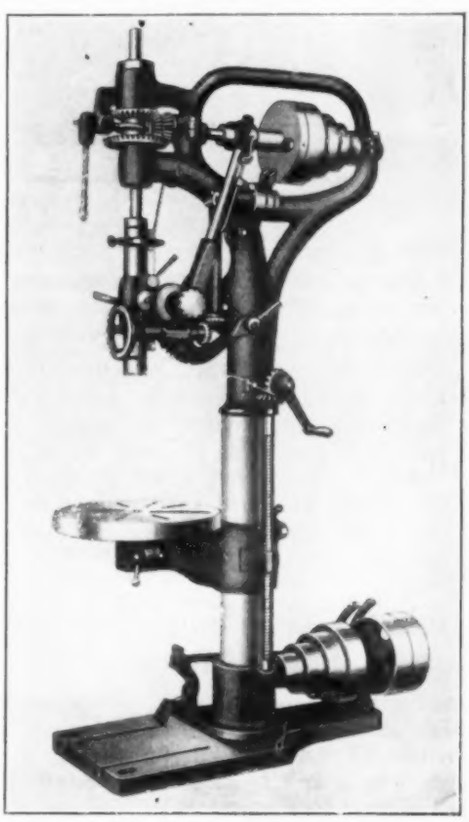


FEDERAL SPRING TOOLHOLDER

for finishing, and the sides are parallel so that the cutter can be reversed without changing the setting of the holder. A setscrew is provided to eliminate the spring feature when it is desired to use the holder as an ordinary lathe tool.

Richards 20-In. Drilling Machine

The illustration shows a new 20-in. drilling machine equipped with back gears, power feed, automatic stop and geared tapping attachment. It is now being manufactured by the Richards Machine Co., 3417-3419 Vliet St., Milwaukee, Wis. The machine has a capacity for drilling holes up to 1½ in. in diameter and tapping holes up to ¾ in. in diameter. The machine has eight speeds, four with open belt, and four with back gears which are inclosed in the upper cone pulley and have a ratio of 4 to 1. The power feed is secured either by means of a belt or by a direct gear drive and gives three



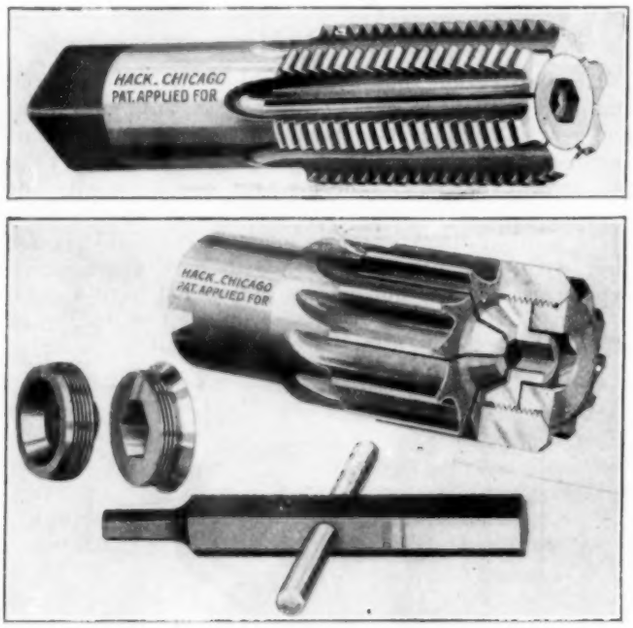
RICHARDS 20-IN. DRILLING MACHINE

Speeds, eight; four with back gears and four with open belts; holes drilled, up to 1¼ in.; holes tapped, up to ¾ in.; belt used, 2 in.; feeds, three, 0.002, 0.005 and 0.010 per spindle revolution; ratio of back gears, 4 to 1; diameter of column, 5⅝ in.; diameter of spindle, 1¼ in.; diameter of sleeve, 2⅜ in.

feeds. The geared-tapping attachment is supported by an arm extending from the front to the rear upper bearing and all gears are of steel. The reverse speed is about one-third faster than the tapping speed and is changed by a movement of the lever directly in front of the operator. Work can be held either on the table or on the base, the former being elevated by means of a crank-operated screw mechanism. The thrust bearings are either of fiber or of the ball type as desired.

Hack Solid Adjustable Reamers and Taps

Figs. 1 and 2 show respectively the Hack solid adjustable reamer and tap made by the American Machine Tool Engineering Works, 4854 West Kinzie St., Chicago, Ill. The adjustment is accomplished by two threaded cones, one for contracting and the other for expanding

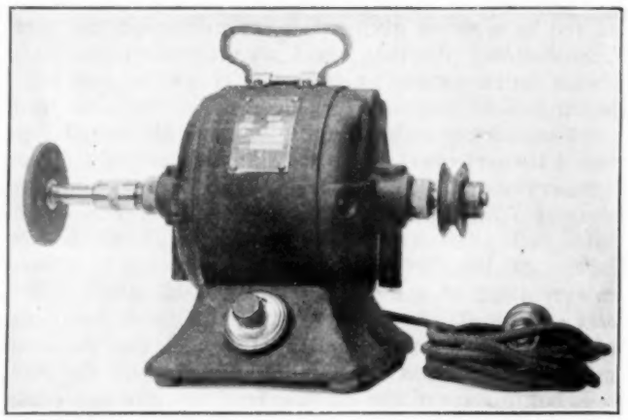


FIGS. 1 AND 2. HACK ADJUSTABLE REAMER AND ADJUSTABLE TAP

the reamer. They are operated by a solid, double-end plug wrench. When a size below standard is required the contracting cone is tightened the necessary amount and the expanding nut brought up against it to act as a locknut. For expanding the tool the procedure is reversed. It is claimed that a set of these reamers will outlast several standard solid sets on account of the possibility of regrinding. They are also valuable for oversize or undersize jobs.

Westinghouse Grinding, Polishing and Power Motors

The small grinding, polishing and power motor shown in the illustration is one of the recent products of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., and is intended especially for light grinding, polishing or power requirements. The machine is portable and is furnished with an attaching cord and snap switch, as well as a handle at the top by which it can be conveniently carried. A single-speed wholly-inclosed motor is used, with long dust-proof bearings. Rubber cushions or bumpers on the base allow the motor to be set on any surface without danger of marring and holes are also provided for fastening down if desired. The illustration shows the a.c. motor with the grinding wheel and pulley, but buffing wheels are also furnished. The machine is also furnished for direct current.



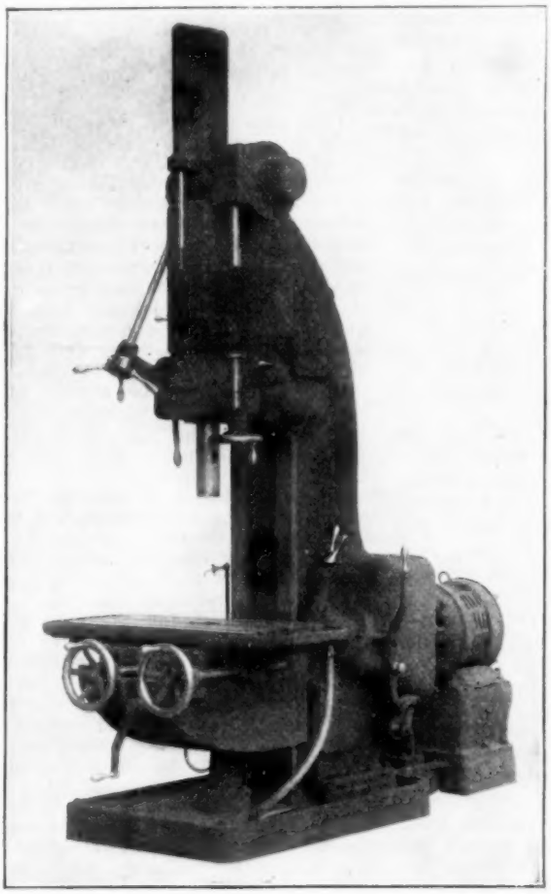
WESTINGHOUSE MOTOR WITH GRINDING WHEEL AND BELT PULLEY

Defiance No. 3 Drilling Machine With Compound Table

The Defiance Machine Works, Defiance, Ohio, is now equipping its No. 3, 24-in. heavy-service drilling machine with a compound table as shown in the illustration. The machine is entirely inclosed, with a gravity oiling system and oil reservoir placed at the bottom of the housing, from which oil is pumped to the top of the spindle, flowing to all parts of the machine and back to the reservoir. The drive is to a single pulley, the spindle speeds being obtained by means of two cones of hardened gears running idle except when one set is meshed by a roll-in gear, operated by a lever at the side of the machine. Helical gears are used on the spindle drive and two keys are used through the driving sleeve into the spindle near the nose to eliminate torsion on the spindle. The thrust is taken by a thrust bearing. Hyatt roller bearings are used on all drive bearings, while slow-feed bearings are bronze bushed. The spindle is of forged high-carbon steel and the thrust is taken on an SKF thrust bearing. The drive is a unit located in the back of the housing, and contains two cones of four gears each running idle except when one is meshed by a roll-in gear. These cones are driven by back gears operated by a friction clutch located on the pulley-drive shaft.

The table is of the box type gibbed to the column and is adjusted vertically by a telescopic screw operated by a lever at the front of the machine. This screw is located far enough from the center of the spindle towards the column to allow boring bars to pass through the table. Four changes of feed are obtained by means of two cones of gears and a power-feed stop is incorporated. The feed is transmitted to the spindle by a worm gear and quick traverse of the spindle is obtained by means of a pilot handle within reach of the operator. The tank for the cutting compound is located in the base and is part of the regular equipment. The lubricant is controlled by a single valve near the outlet, the pump being equipped with a relief valve.

The compound table, which is the new feature of the machine, is not an attachment to the regular table but consists of a special box-type bracket supporting the intermediate slide and the table. It has a working surface 17½ in. x 35 in. The table has a longitudinal adjustment of 18 in. and a crosswise adjustment of 9 in., and has three slots running lengthwise as well as an oil groove. The screw for elevating is the same as that used on the plain table. When the compound table is furnished, it is necessary to use a higher column in order to give the same maximum distance from the nose of the spindle to the table as on the plain machine. A tapping attachment can be furnished as an extra and is an all-geared fixture located directly behind the main-spindle drive gear and operated by a jaw clutch between the forward and reverse gear train.

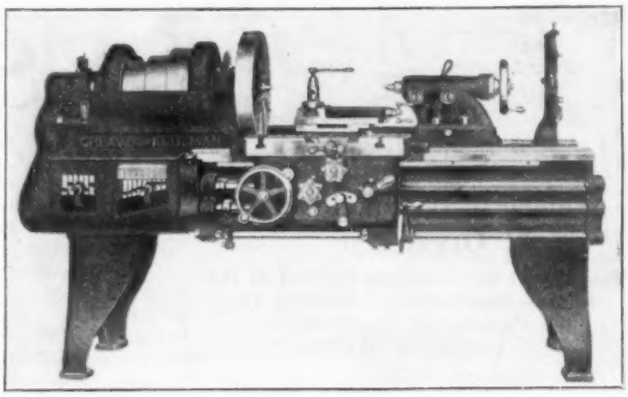


DEFIANCE 24-IN. HEAVY-SERVICE DRILLING MACHINE WITH COMPOUND TABLE

Capacity with high-speed drills in solid steel, 3 in.; length of power feed, 16 in.; diameter of spindle nose, 3⅛ in.; diameter of spindle drive, 3⅛ in.; Morse taper in spindle, No. 5; diameter of spindle sleeve, 3½ in.; width of steel rack in sleeve, 2 in.; pitch of steel rack in sleeve, 6; diameter of feed pinion shaft, 3 in.; pitch of feed pinion, 6; width of helical-drive spindle gear, 2½ in.; center of spindle to face of column, 12 in. maximum distance from nose of spindle to top of table, 32 in.; working surface of compound table, 17½ x 35 in.; vertical adjustment of table, 15 in.; feed changes, four, 0.007, 0.012, 0.018, 0.046 in. per spindle revolution; spindle speeds, eight, 51 to 408 r.p.m.; height of machine with compound table, 9 ft. 8¾ in.; horsepower, 10; floor space, 42 x 67 in.; domestic shipping weight, 5300 lb.

Greaves-Klusman 14-in. Lathe

The Greaves-Klusman Tool Co., Cincinnati, Ohio, has just placed on the market a new 14-in. heavy, quick-change four-step-cone, single-back-geared or three-step-cone friction, double-back-geared engine lathe. The construction is said to be particularly heavy throughout, including a reinforced bed and bearing and a spindle center in back of the center line of the bed. The feed rod and lead screw are supported at both ends of the apron, which is of the double-plate box form. Longitudinal feed stops are provided for motion in both directions. Steel friction gears are used in the apron and these have cast-iron frictions bolted on. The quick-change feeds are geared and a tumbler self-locking device is incorporated for reversing the lead screw.



GREAVES-KLUSMAN HEAVY-DUTY QUICK-CHANGE LATHE

Length of bed, 6 ft. 4¾ in.; swing over ways, 16½ in.; swing over carriage, 10⅝ in.; distance between centers, 37¾ in.; front spindle bearing, 2⅝ x 3½ in.; rear spindle bearing, 1⅛ x 2½ in.; hole through spindle, 1½ in.; taper centers, Morse No. 3; spindle nose, 2½ in. in diameter and 1¼ in. long; threads on spindle nose, U. S. S. 6; width of belt with single back gears, 2½ in.; width of belt with double back gears, 2¾ in.; range of threads cut, 2 to 56; range of feeds, 0.0066 to 0.188 in. per spindle revolution; travel of compound rest, 2½ in.; weight crated, 1700 lb.; weight per extra ft. of bed length, 80 lb.

Beating the Safety Device

BY GEORGE F. KUEHNE

That many accidents occur through the indifference of the workmen rather than lack of adequate safeguards is emphasized by the letter of James Forrest on page 396 of *American Machinist*

The writer has had similar experiences while supervising the production of a press room in a plant where all power presses were provided with safety devices. When a workman was running a punch press that was equipped with the double lever tripping device requiring the use of both hands to operate it, he was very apt to wedge down one side so as to leave one hand free, especially if he were paid by the piece. As the court may uphold a workman in the event of an injury received under such conditions, if there is evidence to show the department foreman was cognizant of the violation and took no steps to prevent it, the foreman was obliged to inform the men that failure to use the safety devices properly would entail dismissal. After the services of a few of the offenders were dispensed with, this trouble was overcome.

Lifting Beyond the Capacity of Crane

BY R. R. SANDS

If there is a heavy flywheel, machine or other object to be lifted, that is beyond the lifting capacity of the crane, lift one end only and block it up while lifting the other end. The object may be lifted a short distance at a time until the desired height is reached.

Sparks from the

American Welding Society Organized

Permanent Organization Formed at the Engineering Societies Building for the Purpose of Supplying Information on Welding

The American Welding Society was formed into a permanent organization on Mar. 28, at the Engineering Societies Building, 33 West 39th St., New York.

The following officers were elected: President, C. A. Adams; vice president (for one year), J. M. Moorehead; vice president (for two years), G. L. Brunner; directors (for one year), W. M. Beard, M. H. Roberts, M. M. Smith, L. D. Lovekin, Alexander Churchward, W. H. Patterson, W. J. Jones, and C. A. McCune; directors (for two years), R. R. Browning, A. S. Kinsey, Victor Mauck, E. L. Hirt, J. F. Lincoln, H. M. Hobart, D. C. Alexander, and H. R. Swartley, Jr.; directors (for three years), L. H. Davis, E. L. Mills, D. B. Rushmore, James Burke, D. H. Wilson, Jr., Hermann Lemp, C. J. Nyquist, and Alexander Jenkins. A secretary, H. C. Forbes, and a treasurer, W. E. Symons, were chosen at a directors' meeting.

By unanimous consent Elihu Thomson was elected the first honorary member.

It is the purpose of the society to become a dependable source of information on welding, not only for the benefit of the manufacturers of welding apparatus and supplies, but also to aid those who use the welding in their production and those who purchase welded goods. Greater stability will be given the welding industry by the standardization of various welding processes and apparatus.

Within the society is what is known as the Bureau of Welding composed of the directors elected by the society and directors appointed by the various national engineering societies, who are entitled to one director each.

Membership Classification

It is intended that the burden of supporting the new society shall fall principally upon those whose business interests would be advanced by the work of the society. These are clearly the companies that manufacture and sell apparatus and supplies for welding, or that employ welding as a process in their output, or that purchase goods welded in whole or in part and desire to do so intelligently. Their representatives will be known as Class A sustaining members accredited to corporations, with annual dues of $100. The number of Class A members from the same corporation is not limited. On the contrary, it is expected that the larger companies at least will support the society by as many Class A members as may accord with their standing in the industry.

Class B.—The fact that a corporation is represented in the Class A sustaining membership opens the Class B membership, with full rights, to others of its employees at annual dues of $20. This class is also intended to provide for any individual not employed by a corporation—consulting engineers, college professors, etc.

Class C.—For the benefit of existing societies that become affiliated with this society through the Bureau of Welding, the Class C membership provides that their members may become associate members in the society at annual dues of $10. These members having their own director participating directly in the work under the arrangement for affiliation would not need to vote or to hold office.

Class D.—Welding artisans may join the society under Class B if they desire, but the Class D membership, with annual dues of $5, offers them the benefits of the society, other than voting and holding office, at a minimum cost.

Class E.—This membership provides for trade associations, putting them in the same category as corporations.

Class F.—This class makes provision for honorary members.

Training of Welders

Investigations thus far show that one of the most important elements in the success of an autogenous welding operation is the skill of the operator. To secure this, uniform methods of training are essential, and the society will take an active part in planning how welders should be trained and how their proficiency may be determined.

* * *

Engineering Advertisers' Association Organized in Chicago

Advertisers and sales managers representing manufacturers in various engineering lines have organized the Engineering Advertisers' Association at Chicago, with the following officers: President, H. L. Delander, advertising manager, Crane Co.; vice president, H. Colin Campbell, director of advertising, Portland Cement Association; secretary, G. H. Eddy, publicity manager, Green Engineering Co., East Chicago, Ind.; treasurer, Ed. J. Pratt, advertising manager, Kellogg Switchboard and Supply Company.

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Erratum

In the article on "Points for Spot Welding" by A. A. Karcher, on page 556, the address of the Challenge Machinery Co. was erroneously given as Grand Rapids, Mich. It should have been Grand Haven, Mich.

Catalogs Requested from the Madrid Consulate

E. E. Palmer, American consul at Madrid, Spain, reports that the consulate in Madrid desires up-to-date catalogs representative of all phases of American industry and commerce.

The following is Consul Palmer's report:

The consulate in Madrid desires up-to-date catalogs representative of all phases of American industry and commerce. The potential importance of the Spanish market in itself and its influence on the Latin-American markets have already been brought to the attention of American manufacturers and exporters. The peculiar situation of Madrid as the geographical, railway, financial and political center of this Spanish market is well known, and the advantage of having such catalogs on file in the Madrid consulate for ready consultation by local distributers to the Spanish trade and by visiting merchants from the Provinces is clearly apparent.

The consulate has recently revised its catalog files and transmitted to the Camara de Comercio (Chamber of Commerce) of Madrid all illustrated catalogs except those manifestly up to date. It is believed that they may have an interest for the members of the Camara de Comercio in so far as they picture American industrial activity, and that the stimulation of such interest at the present time will result in a demand for the most recent catalogs and price lists, which the consulate desires to be in a position to furnish.

Many possible purchasers of American merchandise in Spain have awaited the termination of the war before placing orders, so that they might benefit by the competitive conditions which during the war were practically nonexistent in the majority of lines. That the return of these conditions will necessitate an intensive activity on the part of American manufacturers and exporters who may be interested in the Spanish and Latin-American markets is beyond question, and in making the foregoing request for catalogs and price lists, the Madrid consulate is merely seeking that coöperative assistance from American business interests which it is prepared to offer in the promotion of American foreign trade.

* * *

Pratt & Whitney To Make Hoke Precision Gages

Those who read the article in last week's issue relating to the manufacture of Hoke precision gages at the Bureau of Standards will be interested in the information that the Pratt & Whitney Co. have acquired the manufacturing rights for these gages and will put them on the market. Major Hoke is now associated with the Pratt & Whitney Co. in supervising the manufacture of these gage blocks.

World's Industrial Forge

By E. C. Porter, News Editor

War Contract Claims Should Be Entered at Once

All claims for settlement under the War Contract Validating Bill signed by the President on Mar. 3 must be filed on or before June 30, 1919. Hence clients should lose no time in preparing their papers. All claims are to be separated into two classes. Class A includes those agreements the nature, terms, and conditions of which have been reduced to a contract form or are otherwise established by written evidence. Class B includes all other claims. Claims falling under Class A shall be prepared in quadruplicate on standard forms and forwarded to one of the following boards of the War Department at Washington, depending of course upon who purchased the material: Ordnance Claims Board; Claims Board, Air Service; Claims Board, Chemical Warfare Service; Claims Board, Construction Division; Claims Board, Director of Purchase; Claims Board, Signal Corps; Claims Board, Office Chief of Engineers. Claims based on agreements with the Quartermaster Corps should be addressed to the Claims Board, Director of Purchase, War Department, Washington. Claims coming under Class B shall be prepared in sextuplicate, on standard forms, and forwarded to the Board of Contract Adjustment, Munitions Building, Washington. Standard forms for contract claims, together with further information, can be secured from the respective boards mentioned.

* * *

Training Foremen To Improve Production

The Bullard Machine Tool Co., Bridgeport, Conn., has inaugurated a special course of training for its foremen in order to improve production and labor relations in its plant. A study group has been organized under John E. Calder, M. E., of the Business Training Corporation, New York, and S. H. Bullard, vice president, at the factory, to take up a course in modern production methods. Mr. Bullard is of the opinion that increased efficiency in the plant and more harmonious relations with employees depends ultimately on the foremen, and that foremen trained in the principles of management and production, and having a broader vision of the company as a whole, can get better results. An additional object is to develop competent understudies for the foremen among the more ambitious employees of the plant.

The foremen's class is studying such subjects as plant layout and routing; purchasing, stockkeeping and storeskeeping; reduction of waste; production records; cost accounting; labor turnover; selection, training and supervision of employees; handling different classes of labor; discipline; safety and sanitation. The course consists of the study of text books, problems and conferences, and lasts three months.

* * *

Gear Manufacturers Will Meet in Cleveland

President F. W. Sinram of the American Gear Manufacturers' Association announces that its annual convention will be held at the Hotel Statler, Cleveland, Ohio, Apr. 14, 15 and 16.

The organization includes in its membership representative companies engaged in making gears in the United States and Canada, and promises to be of unusual interest to the manufacturing world. For some years past the American Gear Manufacturers' Association has been striving earnestly to effect an organization that would develop definite means for standardizing its products.

E. W. SINRAM

Papers will be presented as follows: (1) "Gear Steels," by Dr. Parker of the Carpenter Steel Co.; (2) "Proper Sizes and Materials for Gears;" (3) "Worms and Wormwheels," by a representative of Timken-Detroit Axle Co.

Officers of the association are: President, F. W. Sinram, of the Van Dorn and Dutton Co., Cleveland, Ohio; vice president, H. E. Eberhardt, of the Newark Gear Cutting Machine Co., Newark, N. J.; secretary, Frank D. Hamlin, of the Earle Gear and Machine Co., Philadelphia, Penn.; treasurer, Frank Horsburgh, of the Horsburgh and Scott Co., Cleveland, Ohio.

* * *

Installs New Machinery

The Union Switch and Signal Co., Swissvale, Penn., has purchased machinery for finishing crankshafts and camshafts, and will be ready to make deliveries in the near future. This company manufactures its own forgings, and the centralization of the operations required to make finished forgings will be of great advantage.

British Machine Tool Situation

Question of Tariff, Prices and Unemployment, Which May Effect Business in This Country as Well as in England

In a recent paper before the Northeast Coast Institution of Engineers and Shipbuilders, Sir Alfred Herbert, the well-known British machine-tool builder, brought out many interesting points, both as to the early shop practices in Great Britain and as to the later developments during the war. He also took up the question of trade, both present and future, and gave as his belief that the large accumulation of machine tools in Great Britain at the present time need give no particular anxiety to the machine-tool builders. He felt sure the machinery could be satisfactorily employed and that the country would find abundant occupation in supplementing and balancing existing plants and in meeting the demands of new manufacturing industries.

He admits the indebtedness of Great Britain to the United States for much progress in machine-tool production and in workshop methods, and he believes that "taxation on imported machine tools would be a grave disadvantage to the British machine-tool maker as well as to the user. A policy of taxation on imported machine tools might temporarily please those British makers who are either inefficient or who wish to rest on their laurels without constant and renewed efforts, but in the long run it would result in a serious check to progress, both in engineering generally, and in machine-tool manufacture in particular. It must be remembered, too, that the immediate effect of protective tariff is to increase cost of production, and this handicaps the British toolmaker and the British tool user alike in the neutral markets of the world."

He says further: "The introduction of American machine tools, developed under the special conditions obtaining in that country of mass production of output and dear labor, has, in the author's opinion, been of the greatest service to this country in preparing it gradually to meet similar conditions. Any policy which would tend to make it difficult or unduly costly for British machine-tool users to obtain the best machine tools, wherever produced, would be as shortsighted as the restriction of raw materials."

The Scotch Situation

A recent report from England says: "Labor conditions in Scotland are said to continue relatively satisfactory, but the outputs are not sufficient to maintain exports to any degree. All avail-

able blast furnaces are in operation, with most of the output absorbed locally. The pressure of local orders, however, seems to be easing off, but the orders from France and Belgium are becoming increasingly greater. Everything seems to tend to higher prices, and even at the present rate more or less of American material is finding its way into the local markets.

"In the Falkirk district over 2000 women who were engaged on munition work have been displaced by male workers. Efforts are being made, however, to introduce new industries to absorb this labor.

"The fact that structural engineers are keeping busy indicates that enlargements are to be expected. The motor-truck industry seems to be in good condition, and another large airship, 670 ft. long x 79 ft. diameter, has been completed at Inchinnan. It has a capacity of 2,000,000 cu.ft. and a lifting power of about 50 tons.

"Machine-tool makers report a falling off of definite orders, although there is a large inquiry, mostly foreign. The shops are, however, keeping fairly busy at the present time, but fear that it will be necessary to decrease the output unless new orders are received. M'Gregor, Swinburne, Ltd., are filled up with orders for drill chucks and special tools and fixtures, so that the completion of their war contract is not a serious matter.

MANCHESTER

"In the Lancashire district unemployment seems to be on the increase, due largely to the cotton trade. The engineering trade, however, is being affected to some extent. The hopeful sign is that there is a demand for patternmakers and blacksmiths, which would seem to indicate an increase in other lines in the near future.

"Major Frank Gilbreth, of motion-picture study fame, has been lecturing at the Technical College and attracting considerable attention to his methods. E. G. Herbert, Ltd., reports a very good demand for their hacksaws and shop accessories. They are now building a number of hacksaws to cut bars up to 26 in. in diameter, which makes quite a sizeable machine. The Petrie & Co. branch of J. Holroyd & Co., Ltd., are building special lathes for turning railway ties and also some 48-in. lathes of standard design. They are also building a special planer for cutting spiral grooves in chilled rolls. The Manchester Association of Engineers has been discussing the use of automatic machines, which may have a bearing on their more extensive use in this district in the future.

BIRMINGHAM

"The question of no overtime work threatens to develop a discouraging situation in the Birmingham district. Its object, of course, was to distribute the available employment among as large a number of men as possible. The trade unions, however, have recognized the necessity of increasing pivotal or key work, or work on which other industries depend, in order to secure employment in other lines as rapidly as possible. The agreement was reached before any serious damage had been done, which is a good indication of the tendency for both sides to get together.

The lifting of the embargo on overtime applies only to patternmakers, jigmakers, toolmakers, etc., who are engaged on work necessary to speed up reconstruction work in various lines. On production work, the limit of 47 hours per week remains, and there is a common agreement between the operatives and the employers as to the undesirability of systematic overtime work.

Electric heating and electric welding are being very widely discussed in the Birmingham district. A furnace for heat treatment has been invented by C. M. Walter, chief of the Birmingham Municipal Laboratory, with the collaboration of the firm of Kynoch. In addition to this, H. W. Wolton is advocating the use of electric welding and predicting that great savings are possible by its adoption in locomotive work. He holds that both arc and resistance welding have abundantly proved themselves in practice during the war, both in Great Britain and in the United States. Should this be taken up seriously, it would probably provide for the use of increased labor in many districts for the manufacture of the necessary apparatus and its installation.

* * *

Disposition of Surplus Motor Vehicles

Many rumors have been circulated throughout the country as to the disposition of the surplus motor-driven vehicles now owned by the War Department. The following outline of the proposed method of handling this matter is given by the Director of Sales, War Department:

1.—The different branches of the government will be consulted to see whether the surplus in the War Department of automobiles and motor trucks can be used to fill their requirements.

2.—Various manufacturers of vehicles will then be approached to see if they will take over the vehicles of their own make to market them with their own machines, thus giving the government fair market price and at the same time disturbing the market conditions as little as possible.

3.—The net surplus remaining, after the above methods have been followed out, will be disposed of to the public, either through auction or by sealed bids. Full publicity will be given to these sales in order that the government may realize the best results of the sale.

* * *

Bill Introduced To Remove Taxes on Machinery and Tools

Assemblyman John E. Gill, of Trenton, N. J., has introduced a bill in the New Jersey Legislature which would remove all taxes on tools, implements, engines and machinery used or designated to be used in manufacturing, except as are parts of real estate. The measure in effect carries out the idea of the single tax. Advocates of the bill claim that Pennsylvania is rapidly acquiring all manufacturing interests of New Jersey because of having lifted the restrictions of taxation from such property and that Maryland is competing for the location of New Jersey and New York manufacturing industries. William L. McDonald, of Jersey City, representing the iron manufacturers of North Jersey, spoke in favor of the bill at the hearing at the state house. New Jersey manufacturers are in favor of the bill.

* * *

Coal Production Decreases

Less bituminous coal was mined during the week ended Mar. 22 than during any week since Christmas, the amount being 7,477,000 net tons, according to estimates furnished to the United States Fuel Administration by the Geological Survey.

Last year the output recorded for the corresponding week was 11,121,000 net tons, or nearly 50 per cent. more. While the chief cause of the heavy drop in the record was the lack or orders, there was also considerable time lost on St. Patrick's Day.

The loss from full-time production because of "no market" during the week ended Mar. 15 was 42.8 per cent. compared with 41.8, 41.9 and 43.0 per cent. respectively for the three weeks next preceding. Total losses from full time during the week ended Mar. 15 amounted to 48.0 per cent.

Anthracite production during the week ended Mar. 22 is estimated at 1,171,000 net tons as against 1,206,000 net tons the previous week and 2,099,000 net tons for the corresponding week of last year

* * *

Literature for the Foreman

The U. S. Training Service of the Department of Labor has announced that it has in preparation a series of monographs dealing with the special training of foremen.

The material in these discussions is being assembled from all parts of the country and from a great number of different industries. The pamphlets will endeavor to set forth in concise and yet sufficiently detailed form, the approved practices for foremen in the performance of their various duties. The monographs promise to be a valuable addition to the literature dealing with industrial efficiency as it will take up in a practical way each of many problems that the foremen must face.

When the literature now being prepared is ready for free distribution further announcement will be made in the various trade papers. The training service with offices in Washington has already completed several other pamphlets dealing with other phases of industrial training which are free for the asking.

Sale of Surplus Material Progressing

The office of the Director of Sales of the War Department announces that good progress is being made with the disposal of surplus materials and equipment. During the period between Mar. 8 to Mar. 14 total sales of $42,499,827 were made, in accordance with the following list. It will be noted that there has been no sale of passenger automobiles or trucks, notwithstanding frequent reports that the War Department would have many of these vehicles for sale. It is possible that a few trucks will be sold later on. The amount of $450 in the following list under the item of "trucks and trailers" was a sale of kitchen trailers:

Airplanes	$319,000.00
Airplane equipment	679,887.00
Animals	984,018.32
Artillery and artillery ammunition	
Building utilities	25,098.52
Miscellaneous building material	95,035.39
Chemicals and acids	25,000.00
Clothing and equipage	1,773,098.10
Ferrous metal, including scrap	71,977.96
Nonferrous metals, including scrap	234,581.83
Fuels	314,728.40
Hardware	7,876.08
Lumber	32,218.10
Machinery, machine tools and engineering equipment	224,824.85
Masonry material	6,269.00
Medical and hospital supplies	2,122.65
Motors and vehicle equipment	666.44
Motor-vehicle accessories	281.66
Office equipment	64,981.57
Oils, greases, etc	35,228.48
Passenger cars	
Railway material	1,835.54
Real estate	49,283.00
Small arms and small-arms ammunition	
Subsistence	2,895,240.11
Textiles, including wool	26,324,697.90
Trench warfare materials	
Trucks and trailers	450.00
Miscellaneous	25,426.10
Total	$42,499,827.00

Business Items

Williams & Wilson, Ltd., Montreal, have moved to their new machinery warerooms at 84 Inspector St., Montreal.

The Firth-Sterling Steel Co., McKeesport, Penn., has moved its warehouse in New York to 310-312-314 Hudson St.; the Boston warehouse has also moved back to 35 Oliver Street.

The Carpenter Steel Co. has moved its office in Chicago to 1101 West Lake St., where a new branch warehouse has been opened. John B. Guthrie, district sales manager, is in charge.

The Chicago Pneumatic Tool Co. has opened offices and warehouses at 313 Richards Building, Tulsa, Okla., and at El Dorado, Kan. Stocks of repair parts and the company's products will be maintained at both of these points.

The Philadelphia Chapter of the American Steel Treaters' Society was organized on Mar. 17, 1919. The following officers were elected: George W. Pressell, chairman, and Arthur L. Collins, secretary and treasurer.

The Hawkridge Bros. Co., Boston, Mass., has been appointed the New England distributer for the Pressed Metal Radiator Co., Pittsburgh, Penn., for the marketing of their gas-welded, cold-drawn tubing.

The Wallace Barnes Co., Bristol, Conn., has opened branch sales offices at 50 East 42nd St., New York, in charge of district sales manager Lisle K. Lasher, and also at 618 Book Building, Detroit, Mich., with Brown Joyce in charge.

At the regular quarterly meeting of the directors of the Hendey Machine Co., Torrington, Conn., held on Mar. 29, F. F. Fuessenich tendered his resignation as president and treasurer of the company. The directors voted that Mr. Fuessenich be elected chairman of the board of directors for the ensuing year. Charles H. Alvord, who has been vice president and general manager since the death of Mr. Hendey in 1906, was elected president and treasurer, and Robert C. Swayze was elected vice president.

Obituary

FRANK W. HASKELL, president of the Carborundum Co. and its allied companies, died on Apr. 2, 1919. Further particulars of Mr. Haskell's death will be published in the issue of Apr. 17.

* * *

Estimate of 1918 Lumber Cut

A total lumber production of 32,760,000,000 ft. is the estimated cut for the year 1918, on the basis of partial returns received by the Forest Service of the United States Department of Agriculture, from 731 sawmills, each one of which cut about 5,000,000 ft. in the years 1917 or 1918.

In 1917 the total production amounted to 36,000,000,000 ft. The decrease in 1918 is not confined to any one region but is general. It is largest in the southern and eastern states and least in the western states.

* * *

Government Planning Credit Ratings on Foreign Firms

The American Manufacturers' Export Association, New York, has been advised to the effect that the government is planning to give credit ratings on foreign firms. It is understood that, with certain records which have been secured by the Bureau of War Trade Intelligence as a nucleus for the service, it is proposed to build up a new and distinct bureau of the Government, the sole duty of which will be to furnish American exporters with credit ratings on firms in foreign countries who purchase American goods.

This service is as yet in its infancy and is therefore not complete in its scope. It can be used however, and any interested persons may inquire at the Washington office of the association for ratings on firms whose financial responsibility they are anxious to ascertain. While it is unquestionably true that for a short time yet the system will not be complete enough to furnish satisfactory ratings in all cases, yet the number of firms which are listed is sufficient to warrant the statement that there is service there.

Zionist Engineering Organization Wants Machinery and Tools

The Zionist Society of Engineers and Agriculturists, 127 East 37th St., New York, is interested in any and all kinds of machinery, tools, equipment and building materials. This organization is composed of architects, engineers and agriculturists in all branches and specializations, who are engaged in the planning and budgeting Mass-Colonization of Palestine to be undertaken in the near future by the Zionist Organization of America and Europe in behalf of the future Jewish commonwealth.

To facilitate its studies and the agricultural, commercial and industrial planning of Palestine, it desires the coöperation of American manufacturers so that it may be placed in an advantageous position to select and recommend the subsequent purchase of the proper kinds of materials, tools, machinery and equipment to be used in the reclamation work of Palestine.

This organization is at present planning to send an engineering commission to Palestine for the purpose of making a survey of the natural resources.

Personals

CHARLES A. HEIL has been made district sales manager of the Carpenter Steel Co., 400 Lakeside Ave., N. W., Cleveland, Ohio. He succeeds James W. Sederquist, who resigned.

W. L. ROMAINE, secretary of the Badger-Packard Machinery Co., Milwaukee, Wis., has resigned to become special representative of several machine-tool lines in the northern Illinois and Wisconsin territory.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

A man in France desires to secure an agency for the sale of printing machines, paper, ink, hardware, machine tools, and sewing machines. Quotations should be given f.o.b. New York. Correspondence should be in French. Reference. 28939.

An engineer in Wales desires to secure an agency for the sale of all kinds of engineering tools, supplies, and metals. Terms of payment, cash against documents at bank. 28873.

A man in Italy desires to receive an exclusive agency for the sale of electrical machinery, magnetic sheet steel, batteries, frequency meters, phasometers, current compters, instruments of precision, electric apparatus for mines, for chemical industries, and for electric railways; also, insulating material, mica paper, varnish, fiber and cable insulators, medical applications, marine installations, magnetos, telephone apparatus, and telephone switchboards. Correspondence may be in English. References. 28897.

A company in Italy desires to secure an agency for the sale of agricultural machinery of various kinds. Correspondence should be in Italian. References. 28899.

New Publications

Screw Threads Bibliography.—By Henry E. Haferkorn, librarian Engineer School Library, Washington, D. C. Sixty-two 6 x 9-in. pages; bound in paper. Published by the Press of the Engineer School, Washington, D. C.

This work is a bibliography of available material on the systems and classifications of screw threads, including tolerances, allowances and symbols of nomenclature, and on gages, methods of testing and specifications. The book was prepared by Mr. Haferkorn at the request of the United States Screw Thread Commission, and is arranged in alphabetical order according to authors and titles, and is also supplied with an index of subjects. The aim of the work is to furnish accounts as complete as possible of the various domestic and foreign forms and systems of screw threads, together with reports from professional men relating to their actual experience and study along these lines.

Works Committees and Joint Industrial Councils. A. B. Wolfe, Industrial Relations Division, U. S. Shipping Board, Emergency Fleet Corporation, Philadelphia. Paper binding.

A branch of the Industrial Relations Division was organized for the purpose of analyzing and making available to American manufacturers both English and American experience in industrial relations under war time conditions. Many lines of inquiry were started but only a few of these inquiries had been completed at the time of the signing of the armistice. One of these which was concluded is here presented as a report on Works Committees and Joint Councils. It is divided into five chapters with an introduction and seven appendices. The headings of the chapters are as follows: The Human Factor in Industry; Psychology, Democracy and Efficiency; The Whitley Committee Recommendations; Works Commitees; Works Committees in the United States.

Manual of Inspection and Information for Weights and Measures Officials.—By F. S. Holbrook, inspector of works and measures, United States Bureau of Standards. Two hundred and forty-six 4½ x 7 in. pages; illustrated; bound in cardboard. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., for free distribution.

This book has been published primarily for the use of official sealers and inspectors appointed to enforce weights and measures laws and ordinances, but it is of value to anyone who has occasion to inspect and test weights and measures and weighing and measuring devices of the types ordinarily found in commercial use. It contains complete instructions, together with specifications and tolerances for the testing of all kinds of scales, length measures, etc; general instructions concerning the enforcement of law; lists of standards in apparatus; method of keeping office records, etc. Appendices are included containing the federal weights and measures laws with rules and regulations, a model state law in relation to weights and measures, a description of the metric system, general tables, conversion tables, and tables of equivalents. Copies of this book may be obtained by addressing the Bureau of Standards, Washington, D. C.

Applied Mechanics—Vol. II, Strength of Materials.—By Charles E. Fuller and William A. Johnson. First Edition. John Wiley & Sons, Inc., New York. Five hundred and thirty-eight pages, with numerous problems and illustrations. Price, $3.75.

This is a rather comprehensive treatment of the subject generally known as "Strength of Materials," and follows the conventional lines of development, beginning with the physical properties of materials and taking up in order the analysis of stress and strain, beams, combined stresses, the theory of flexure, columns, shafting and springs, curved bars, arches and catenaries, cylinders and plates, and reinforced concrete. It is essentially a textbook and requires of the student a knowledge of differential and integral calculus and theoretical mechanics. The methods of the calculus have been freely employed throughout and there is also a generous use of graphical methods of solution and representation of results. The book will recommend itself to teachers on account of the many problems introduced, solutions being included where their use would be an aid in clearing up obscure points. As a reference book for graduate engineers it should be of considerable value on account of its completeness and also because all the steps in the derivation of the more intricate formulas have been included, particularly where differential equations are employed—a great help to the man who has not time to keep his hand in at this sort of exercise. The work has been so arranged that parts of some of the earlier chapters and all of some of the later and more difficult ones may be omitted for a shorter course in the subject. Although the treatment is decidedly theoretical attention is called to the limitations of the theory and the divergence of actual conditions from those assumed.

Compressed Air Plant.—By Robert Peele, Mining Engineer and Professor of Mining in the School of Mines, Columbia University. Four hundred and eighty-five 6 x 9 pages; with many diagrams, illustrations and tables; bound in cloth. Third edition. Published by John Wiley and Sons, Inc., New York. Price, $4.25.

This work is an effort to combine the rather scattered information on the subject. It offers to the practicing mining engineer a reference book which is encouragingly free from mathematical formulas. A chapter is devoted to the general theory of the compression of air, and in it the deductions of the more important formulas are given, such as those used for finding the horsepower for single- and multiple-stage compression. The first part deals with the construction and operation of air compressors, but many of the details of design are omitted as not being of particular value to the users of such apparatus. The second part is devoted to applications of compressed-air transmission of power to machine drills, pumps, locomotives, rock-channeling machines, etc. The following list of chapter headings will give a good idea of the comprehensive nature of the text: Structure and operation of air compressors; the compression of air; wet compressors; dry compressors; compound or stage compressors; air-inlet valves; discharge or delivery valves; mechanically-controlled valves; performance of air compressors; air receivers; speed and pressure regulators; air compression at attitude above sea level; explosions in compressors and receivers; air compression by action of falling water; conveyance of compressed air in pipes; compressed air engines; freezing of moisture; reheating compressed air; compressed air rock-drills, hammer drills; coal-cutting machinery; channeling machines; operation of mine pumps by compressed air; pumping by direct action of compressed air; compressed air haulage.

Starrett Data Book for Machinists.—Vol. II of Starrett books. One hundred and seventy-nine 4½ x 7-in. pages; bound in flexible red leather. Published by the L. S. Starrett Co., Athol, Mass. Price, 50 cents.

For the convenience of the expert machinist who often wants certain shop information and data not easily remembered and seldom easy to find when needed the L. S. Starrett Co. of Athol, Mass., has just published the Starrett Data Book for Machinists. To insure its covering the field thoroughly the Starrett company secured as editors Prof. H. P. Fairfield of Worcester Polytechnic Institute; N. J. Bethel, production manager of the Taft-Peirce Co.; N. H. Edge, factory manager of the Locomobile Co., and J. C. Spence, superintendent of the Norton Co., and through their coöperation the company has been able to include practically all of the information, formulas, etc., essential to good shop practice as found in the different classes of work produced in the several plants under the direction of the collaborating editors and has avoided the elementary and theoretical matter which is of little or no value to a practical man.

The book contains tables, rules, data, etc., is freely illustrated with line drawings, carefully indexed, and presents in a convenient form the information that the practical expert machinist so frequently requires. The volume under review is divided into 21 general heads, the page references in the index showing over 500 subjects treated, the information being given in the form of tables, formulas and charts and is confined wholly to the practical phases of every-day machine-shop practice on the assumption that the men who will use the book are experienced, familiar with their tools and shop methods and beyond the need of explanatory and elementary advice. Among the general subjects treated are Laying Out; Screw Machines; Heat Treatment of Steel; Threads and Screws; Gears and Gearing; Lubricants; Grinding, Belting and Shafting; Milling; Tapers; Taps; Turning and Boring, etc.

Trade Catalogs

Maxim Products. Maxim Silencer Co., Hartford, Conn. A single sheet folder showing the various steel tubings by the Maxilent Process.

Electric Butt Welding. The Ready Tool Co., Bridgeport, Conn. Circular, pp. 4, 8½ x 11 in. Examples are given to show economies effected in high-speed carbon and tool steel.

Electrical Supplies. The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has issued a catalog in which all of its electrical supplies are listed.

Forthcoming Meetings

American Association of Engineers. Annual meeting has been scheduled for May 13 at Chicago.

American Society of Mechanical Engineers. Spring meeting to be held at Hotel Statler, Detroit, Mich., June 16-19, 1919. Secretary, Calvin Rice, 29 West 39th St., New York City.

American Society for Testing Materials. The 22nd annual meeting of the society will be held at Atlantic City, N. J. on June 24-27, 1919, with headquarters at the Hotel Traymore. Alfred D. Flinn, secretary, 29 West 39th St., New York.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month. Young's Hotel. Donald H. C. Tullock, Jr., secretary. Room 41, 166 Devonshire St., Boston, Mass.

Engineers' Club of Philadelphia will hold its regular meeting at Witherspoon Hall, Tuesday evening, April 15, 1919. Announcement has been made of a special meeting on Apr. 23, at which Arthur J. Baldwin, vice president of the McGraw-Hill Co., Inc., will speak.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

National Foreign Trade Council. Annual meeting at Chicago, Apr. 24-26. O. K. Davis, secretary, 1 Hanover Square, N. Y.

National Machine Tool Builders' Association. Spring convention to be held at Atlantic City, N. J., May 12 and 13, with headquarters at Hotel Traymore. C. Wood Walter, Cincinnati, Ohio, secretary.

National Metal Trades' Association will hold its 21st annual convention at the Hotel Astor, New York, Apr. 23 and 24.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Philadelphia Foundrymen's Association. Meeting first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn., Howard Evans, secretary, Pier 45, North Philadelphia, Penn.

Providence Engineering Society. Monthly meeting fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796. Providence, R. I.

Rochester Society of Technical Draftsmen. Annual meeting and election of officers to be held June 28. Other meetings on Apr. 24, when Allen S. Crocker will speak; also on May 29 with Maurice A. Wilder as the speaker. Secretary, O. L. Angevine, Jr., Rooms 131-137, Sibley Block, Rochester, N. Y.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 240 Broadway, New York.

United States Chamber of Commerce. Annual convention to be held at St. Louis Apr. 28, 29 and 30.

Western Society of Engineers, Chicago, Ill. Regular meetings, first, second, third and fourth Mondays of each month, except July and August. Edgar S. Nethercut, secretary, 1735 Monadnock Block, Chicago, Ill.